# The Electrical World.

Vol. XXIII. NEW YORK, JANUARY 27, 1894. No. 4.

PUBLISHED EVERY SATURDAY BY

**THE W. J. JOHNSTON COMPANY, Limited,**

41 PARK ROW (TIMES BUILDING), NEW YORK.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 927 Chestnut Street.

*SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.00,*

in the U. S., Canada or Mexico; other Postal Union countries, $6.

*In requesting your address changed, give* old *as well as new address.*

Established 20 years ago, THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America, and has well maintained its lead. It has the Largest Circulation of any electrical periodical in the world, and is the Best Advertising Medium.

In the growth of the paper in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits has not failed to be appreciated by advertisers. The following table shows its steady onward march in this department of business. The first issue of

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1880 | contained | 25 | different | adv'ts. | 1887 | contained | 154 | different | adv'ts. |
| 1881 | " | 28 | " | " | 1888 | " | 175 | " | " |
| 1882 | " | 45 | " | " | 1889 | " | 234 | " | " |
| 1883 | " | 63 | " | " | 1890 | " | 289 | " | " |
| 1884 | " | 82 | " | " | 1891 | " | 325 | " | " |
| 1885 | " | 100 | " | " | 1892 | " | 316 | " | " |
| 1886 | " | 138 | " | " | 1893 | " | 317 | " | " |

The first issue of 1894 contained 320 different Advertisements.

No announcements of the Publisher are included in this list.

THE ELECTRICAL WORLD'S Advertising Rates are much lower than those of any other similar publication, circulation and standing considered, and vary according to space, position and number of insertions. Quotations promptly furnished.

Address and make drafts, orders, etc., payable to

**THE ELECTRICAL WORLD,**
41 Park Row, New York.

VOL. XXIII. NEW YORK, JAN. 27, 1894. NO. 4.

CONTENTS.

Editorial ..... 105
Dr. Heinrich Hertz ..... 107
Meeting of the American Institute of Electrical Engineers.... 108
Long Distance Transmission with Continuous Currents, by F. C. Perkins ..... 109
A Current Without a Difference in Potential..... 110
The Saving of Copper in the Three-Wire, Three-Phase System, by Dr. Louis Bell..... 111
Relative Costs of Distribution by Different Electrical Systems, by A. E. Kennelly ..... 111
Relative Cost of Copper for Conductors, by Chas. P. Steinmetz. 112
On the Design of Electromagnets for Specific Duty, by E. R. Carichoff ..... 113
Calculating the Resistance of Wires for Alternating Currents, by Carl Hering..... 114
Is Telephonic Induction Electrostatic of Electromagnetic?-II., by F. W. Dunbar ..... 115
Non-Infringing Telephone Transmitters, by W. A. Rosenbaum. 117
Theory and Design of the Closed-Coil, Constant-Current Dynamo, by Prof. H. S. Carhart..... 118
Prof. H. A. Rowland vs. the Cataract Construction Company. 119
Digest of Current Technical Electrical Literature, Compiled by Carl Hering ..... 122
What Is Said of the New Form..... 126
Moonlight Tables for February, 1894..... 126
Regulation of Arc Currents, by Daniel Higham..... 127
The Brown Telephone ..... 128
A New Indicator ..... 128
Bimetallic Wires for Telephonic Transmission..... 128
Long Distance Transmitter..... 129
DEPARTMENTS:
Financial ..... 130
Special Correspondence ..... 130
News of the Week..... 131
Trade and Industrial Notes..... 134
Illustrated Record of Patents ..... 135

OUR PATENT RECORD.

Hereafter we shall give in our patent record a weekly list of patents which have expired during the preceding week. This feature, we think, will be found of interest by our readers, and especially to inventors, who may have been deterred by the existence of fundamental patents from perfecting improvements.

RAPID TRANSIT FOR NEW YORK.

The proposition of the Wilson syndicate for constructing an underground rapid transit system in New York seems to be an ideal plan, both from a public and engineering standpoint. The underground feature obviates the barbarous desecration of the streets by unsightly structures and the further increase of the intolerable noises, whose continuance with the present elevated system makes it impossible for New York to be favorably compared in an aesthetic sense with any of the great cities of Europe, and renders some of the most desirable parts of the city intolerable for residence besides largely detracting from their business value. As a feature of the Wilson plan is that the cars are to be propelled, lighted and heated by electricity, the electrical fraternity will take a warm interest in the success of the scheme, which might with great benefit be made to take the form of an organized support of the measure before the Legislature and Constitutional Convention. The impetus which the adoption of the scheme would undoubtedly give to electrical traction in general should enlist the direct aid of all those connected with the electrical industries, while the immense benefit to the residents of New York of the adoption of this system over the proposed extension of the elevated railway should cause them to exert their utmost endeavors in its support. With such a method of traction as that proposed, electricity would have an ideal opportunity to make manifest its advantages, and the demonstration would have its effects in many other directions on the hundreds of thousands who would thus daily experience benefit from its use.

THE DESIGN OF ELECTROMAGNETS.

In another column Mr. E. R. Carichoff makes an important addition to our knowledge of the design of electromagnets, which, indeed, may be considered one of the most practical contributions to the subject yet made. Prof. S. P. Thompson and others have pointed out in a more or less general way the principles governing the design of electromagnets for various purposes, but so far as we know, no one had heretofore shown how they were to be applied, as regards the point referred to, to specific cases. By the method given not only may a magnet be exactly designed for a given purpose, but by changing the polar area to satisfy the condition of maximum effect magnets already designed may be made more efficient. The one point of weakness in the method is the necessity of knowing the iron curve, as it would not be practicable to determine this for each case, although with Kennelly's apparatus for this purpose, described in these columns several months ago, it would not be a matter of much difficulty to do so. It would be interesting to have tests made on different commercial irons used in electromagnets in order to determine if the variation is sufficient to affect the method proposed, and to furnish curves from among which the proper one may be selected for a specific case, should the variation exceed an amount which otherwise would render the method described inapplicable.

HEINRICH HERTZ.

By the death of Heinrich Hertz at the early age of thirty-seven years, science has suffered an affliction even greater than through the similarly premature deaths of Pascal and Fresnel. What he had already done for science had come to be regarded as merely a foretaste, and the entire scientific world was confidently relying on the genius of the young German professor for extensions of his researches, even to the final mysteries which nature has so long and carefully guarded from the covetous mind of man. It should be borne in mind that the researches of Hertz have not merely a bearing on the phenomena of electricity and light. The mechanism of molecular physics, which carries with it almost the solution of the problem of the universe itself, was concerned, and therefore the loss through his death is not confined to the scientific world alone, but intimately concerns the entire human race. While thus the master spirit is gone, the field he opened up and the impetus he gave to research remain, and will doubtless be accelerated now that scientific workers are thrown upon their own resources by his untimely death and can no longer rely upon his genius for further extensions. In another column we print a heartfelt tribute of Dr. Oliver Lodge to his late friend and co-worker, which expresses strongly the great esteem in which the charming personal character of Dr. Hertz, in which the modesty of true genius was predominant, was held by those who had the honor of his acquaintance.

PROF. ROWLAND'S SUIT.

The report of the court proceedings in the suit of Prof. Rowland against the Cataract Construction Company, which we print elsewhere, has an interest not usual in legal cases. The testimony gives more of an insight of the genesis of the Niagara plans than has heretofore been permitted, and the side light thrown on the business features of "experting" is also not without interest. From the testimony it would appear that there is a distinction recognized in the "profession" between an "expert" and an "expert witness"—the latter being presumably one whose chief qualification lies in bringing out the strong points of a case and dodging the weak ones rather than in the possession of actual scientific knowledge in regard to the subject matter of a case, which also explains the equivocal professional standing of many so-called experts, and the prejudice becoming attached to the word. The verdict of the court is a recognition of the undoubted value of Prof. Rowland's services to the Niagara project, although, probably on account of the estimate of the plaintiff in his original bill of $10,000, it does not award anywhere near the amount claimed in the present suit. The claims, however, in regard to originating the main features of the plans adopted for the Niagara transmission are not settled by the verdict, and still remain undecided as far as the public is concerned. The testimony of Prof. Rowland on the one hand and Prof. Forbes and Mr. Rankin on the other are diametrically opposed on some of the most important points. While Prof. Rowland claims credit for settling the question of frequencies, various details of the electrical machinery and transforming apparatus, Prof. Forbes testified that all of the essential features of the plan adopted were determined upon before he had seen Prof. Rowland's report, and the Westinghouse company has claimed that the design of the dynamo originated with their engineers. As the counsel for the defense virtually acknowledged the great value of Prof. Rowland's services aside from any question of priority, no direct effort was made in the suit to bring up this question, but we trust that in view of the claims and counter claims made, both here and in Europe, the Construction Company will feel it but fair to all concerned to authorize the publication of a history of the Niagara plans from the beginning, and thus set at rest a disagreeable controversy, and also add an exceedingly interesting chapter to engineering literature. The policy of secrecy pursued by the company is at the bottom of much of the suspicion with which its motives have been viewed, and has also resulted in placing some of its professional advisers in an awkward position that a more open policy would have avoided.

RELATIVE COST OF COPPER FOR CONDUCTORS.

The articles elsewhere by Messrs. Bell, Kennelly and Steinmetz form the most important contribution yet made to the subject of the relative cost of conductors in different electrical systems, and may be said to definitely settle a question in regard to which but little information has heretofore existed. Both Kennelly and Steinmetz call attention to an obvious correction to the results calculated in the article upon which they comment, in regard to the additional saving in the two-phased system by having the current density the same in each of the three wires of that system. This introduces a correction of about three per cent. in the results there calculated and brings them into exact conformity with those given by Kapp. The extension of the comparison by both of these writers is interesting. Mr. Kennelly shows that while by a different connection in the three-phased system a saving of 300 per cent. may be obtained on the basis of effective E. M. F., the insulation stress is not changed, which illustrates the worthlessness of comparisons on that basis. Both writers agree that there is no fair basis of comparison, as we have pointed out before, between direct and alternating current systems, and Steinmetz calls attention in addition to the electro-chemical stress of continuous currents, which he states is generally far more severe than the electrostatic stress. As an important complement to the mathemathical demonstration is Dr. Bell's account of a practical proof of the saving of copper in the three-phased over the simple alternating system, which will doubtless set the matter at rest in the minds of those who think of mathematics as a mere system for juggling with figures—in which supposition, it may be remarked, they only too often have reason. The criticism of Mr. Steinmetz in regard to our remarks on the importance of line insulation would be perfectly just if the statement referred to were taken in an absolute and not in a comparative sense, as meant, though we now see that it was ambiguously expressed. The idea intended to be conveyed was that until a practical limit of insulation stress was reached, comparisons between alternating current systems based upon insulation stress alone would not be just. That is, the undoubted superiority of the three-phased system in this respect over other present systems would not assume the weight indicated by the ratio expressing it until actual practical difficulties of insulation intervened. With the voltages that have been thus far used, or are now proposed for use, it does not appear that we have approached a limit of insulation that would as yet justify any great weight being given to the additional insulation stress of one system over that of the other, though, of course, when such a practical limit is reached, or when the difficulties of insulation become proportional to the increase of voltage, this factor will assume its full importance.

**The Berliner Suit.**

We are informed by the attorney for the government that the evidence in support of the bill of charges in the Berliner suit is in, the evidence of the defense nearly in, and that it is the present expectation of the counsel that the evidence on both sides will be completed and the cause ready for hearing before next summer.

## Dr. Heinrich Hertz.

The death of Dr. Heinrich Hertz, which took place at Bonn on Jan. 1, robbed the world of one of its most brilliant young scientists. In the thirty-seventh year of his age, with an enviable record for the past, and a genius and energy possessed by but few, he gave promise of achieving even more important results in the future, and of attaining a still greater reputation.

He was the son of Dr. Gustavus Hertz, and was born at Hamburg on the 22d of February, 1857. His primary education was received in a private school, supplemented by one year in the high school. At the age of eighteen he decided to become a civil engineer, and devoted himself to special studies in that direction, but finding that it would require years of work to gain a livelihood from this profession and that the work itself was full of monotonous details, he abandoned the idea, and after serving his time in the army he went to Munich in 1878, where he studied physics under Von Helmholtz. In 1880 he became assistant to that great physicist, and three years later accepted the chair of theoretical physics

HEINRICH HERTZ.

at Kiel. From 1885 to 1889 he was professor of physics in the Technical High School at Carlsruhe, and in 1889 he succeeded the well-known physicist, Clausius, at the University of Bonn, where he remained until his death.

Dr. Hertz had a charming personal character and possessed in a marked degree that modesty which is so often characteristic of true genius.

The investigations of Prof. Hertz were principally in electricity, and his experimental discovery of the relation between light and electricity created a profound sensation in scientific circles. In brief, he proved that the rays of electric force follow the same laws of transmission, reflection and refraction as the rays of light; in fact, that they are only light rays of much greater wave length. Dr. Oliver J. Lodge, who is peculiarly well qualified to pass judgment upon Prof. Hertz's work, has given the following estimate of that scientist in the current number of the London "Electrician":

"Not a student of physical science on the planet but will realize and lament the sad loss conveyed by the message, 'Hertz is dead.' After thirty years of study and preparation, he achieved his great discovery in the comparative quiet and isolation of Carlsruhe, and now, only a few years later, his work for the human race is over, and he has entered on a new career.

"Ever since he went to Bonn he has been ailing; he was never strong, apparently, as a child, and his friends have long been anxious about him. A little time ago he seemed to be mending, and we heard better accounts; but since the serious winter began he grew worse, and with the incoming of the new year he passed out of our ken, not yet thirty-seven years of age.

"It is not the time to attempt a critical estimate of his work. The greater part of his short life was spent in thorough equipment of himself for the successful quest of the unknown among the most solid and difficult branches of science. Up to the age of twenty-one he studied as an engineer—an admirable training for a physicist, as many can testify. Then he graduated at Berlin, and became assistant to von Helmholtz. Here the writer first made his acquaintance thirteen years ago, when, on calling upon the distinguished professor of physics at the University of Berlin, Hertz did the honors of the laboratory.

"During the years at Berlin he published many investigations and theses of a weighty, not to say ponderous, order, and became known in strictly scientific circles as a learned and rising physicist of whom much might reasonably be expected. In 1885 he became professor at the Technical College at Carlsruhe, and in 1889 he received his call to succeed Clausius in the University of Bonn. But it was during an investigation begun in 1887, at the instance of Prof. von Helmholtz, on some obscure phenomena occurring in induction coil circuits that led him to that brilliant series of experiments which have immortalized his name, and may even be said to have created an epoch in science. July, 1888, saw the publication of the most striking memoir of that series, and at the Bath meeting of the British Association in that same year all the world was advised of the discovery by Fitzgerald, then president of Section A.

"Had it not been for the preparedness of British physicists in this matter Hertz's discovery might have been left to leak out gradually, and be more or less misunderstood for the course of ten or twenty years, as usual. Continental science, was, in fact, by no means ripe for a clear appreciation of these experiments, and even now it is surprising that a Continental philosopher should have thus reaped the fruits of the theoretical seed sown in England. However, so it was; Hertz stepped in before the English physicists, and brilliantly carried off the prize. He was naturally and unaffectedly pleased with the reception of his discovery in England, and his speech on the occasion of the bestowal of the Rumford medal by the Royal Society will long be remembered by those who heard it for its simple-hearted enthusiasm and good feeling. His letters are full of the same sentiment, and there is no doubt that, in addition to being a capable and well-armed investigator, he was also a modest and courteous gentleman. We hoped many times to see him at one of the meetings of the British Association, where he would have been sure of a cordial welcome, but every year he had to excuse himself—once on the ground of military service demanded of him at some autumn manoeuvres. It is strange to remember that such a man, with his rare combination of experimental facility with high mathematical equipment, was regarded by his nation not only in the light of a university teacher, but also as a locomotive unit capable of emitting and receiving bullets. However, this compulsory military service may have conferred upon him some needful relaxation and change of thought, if the discipline was not too trying for his state of health.

"In addition to his physical investigations it may not be generally known that Hertz was also genuinely though not

obtrusively or actively interested in certain modern discoveries in experimental psychology, and he was a corresponding member of the Society for Psychical Research. Some experiences of his in this connection had made a distinct impression upon him, and he was prepared to examine into the possible truth of phenomena such as a short time ago would have been by most men in his position scouted as hopelessly improbable or absurd.

"It would be a mistake to suppose that his best known research is all we owe to him. He made experiments on the time of contact of elastic bodies of certain shapes before they rebounded, and a minor or collateral discovery of his concerning the curious effect of ultra-violet light in promoting electrical discharge has led to a long series of experiments, and seems likely to afford important assistance in the difficult task of disentangling the relations between electricity and matter—the most promising and suggestive branch of modern physical chemistry.

"But the writer does not intend to be drawn into a comment on Hertz's scientific work; he feels too keenly the serious blow which the loss of so young and capable a man entails upon all workers in the same regions of science.

"We have lost the skill and power of work, the trained judgment, the patience and store of learning with which he was endowed; and those that are left must close up the ranks and advance as best they can without the aid of that able and friendly co-worker."

## The Meeting of the American Institute of Electrical Engineers.

The eighty-third meeting of the American Institute of Electrical Engineers was held Wednesday evening, Jan. 17, at headquarters, 12 West Thirty-first street, with President Houston in the chair. The paper of the evening was read by Dr. Louis Bell, the subject being "Practical Properties of Polyphase Apparatus." The paper is one of unusual excellence, and with the very able and lively discussion which followed made the meeting one of the most notable in the history of the institute. Such a paper was particularly welcome in view of the great falling off in the character of many of those read during the present Institute year, and as a consequence the attendance was very large, and included an unusual proportion of the more eminent members of the institute, who are only attracted by papers of intrinsic merit.

The paper was compactly written, and though not of inordinate length, contained much information. The principal points considered were the starting and running torques of polyphased motors; relative merits of biphased, triphased and higher phased apparatus, including circuits; also the question of the best frequency, with reference to arc and incandescent lighting, power transmission and the mechanical exigencies of construction of apparatus.

The discussion was of an important character and participated in by Mr. Stanley, who gave a very interesting account of his company's biphased plant in Pittsfield, Mass.; by Mr. Steinmetz, Mr. Crosby, Mr. Darlington, Dr. Pupin and Mr. Mailloux. Profs. Forbes and Rowland, although present, did not join in the duscussion.

Mr. Steinmetz is always interesting, but on this occasion he was unusually so. He said that the rotation of a copper disc by a rotary magnetic field produced by stationary electromagnets was described by Arago. In reply to Mr. Stanley's claim for the merits of condensers and his disparagement of synchronous motors, Mr. Steinmetz also said that properly designed synchronous motors had a condenser action of their own, obviating the necessity of separate condensers, and also called attention to the fact that he had made this statement before at an institute meeting. He stated that he had made experiments on the frequency at which flickering was visible and found that the greater the brilliancy, that is, the higher the temperature, the higher frequency at which flickering was visible. With the usual brilliancy the flickering at 18 or 20 periods was abominable and at 30 still perceptible. Mr. Crosby said he would like to ask, inasmuch as the personal equation entered largely into the matter of flickering, whether any one else had observed the lights at the same time with substantially the same results. Mr. Steinmetz said that Mr. Eickemeyer was present, also Prof. Forbes and some workmen, and that all arrived at substantially the same conclusion.

After the discussion the report of the Committee on Units and Standards was read, recommending the names Gilbert, Weber and Gauss for C. G. S. units. This was objected to by Messrs. Wolcott, Steinmetz and Mailloux, and finally, on the motion of Mr. Mailloux, the report was laid on the table.

The report of the Committee on Revision of Election Rules was read by the secretary of the institute in the absence of the chairman, Dr. F. Benedict Herzog. It makes certain recommendations requiring that the balloting envelopes emanating from other sources than the secretary's office shall be marked "unofficial," and that the number of votes in nominations shall be placed opposite the name of each candidate on the "general proposal list" accompanying the ballots distributed. This report, which is designed to prevent a reoccurrence of the disgraceful election tactics employed last year at the annual election, will come up for discussion at a future meeting, and its adoption or rejection will have a vital bearing upon the future prospects of the institute. It is very much to be regretted that action was not taken at the present meeting, in view of the approaching annual election.

The following are the recommendations of the Committee on Units and Standards, signed by Kennelly, Crocker, Geyer and Hamilton:

The provisional adoption of

The term "gilbert" for the C. G. S. unit of magnetomotive force, the same being produced by 0.7958 ampere-turn approximately.

The term "weber" for the C. G. S. magnetic unit of flux, sometimes described as the C. G. S. line of flux.

The term "oersted" for the C. G. S. unit of reluctance.

The term "gauss" for the C. G. S. unit of flux density, or one weber per normal square centimetre.

The committee, it will be remembered, in its previous report, dated June 20, 1891, advocated that the above terms should be accorded to magnitudes in conformity with the "practical" electromagnetic system, and therefore following in natural order and extension from one volt, ohm, ampere, and other units in universal use.

As, however, so important a series of new unit magnitudes could only meet with general recognition and favor under the authorization of an international electrical congress, which authorization has been withheld at the recent congress at Chicago, and since objections have been raised to those magnitudes, your committee considers that the urgent need for names specifying the principal quantities dealt with in magnetic circuits can best be met with general favor by adopting for those names the fundamental unit magnitudes of the international C. G. S. system after the precedents already established in the cases of the C. G. S. units of force and work, entitled respectively the "dyne" and "erg."

At the meeting of council held on Jan. 17 the following associate members were elected:

Comfort A. Adams, Jr., Cambridge, Mass.; U. N. Bethell, New York City; Francis Broadnox, New York City; Joseph Broich, Brooklyn, N .Y.; Sigfried H. Ende, New York City; Thomas Francis Flanagan, Portsmouth, N. H.; Bertram P. Flint, New York City; James Mason Knox, New York City; Wynn Meredith, San Francisco; Max Osterberg, New York City; R. L. Selden, Jr., Deep River, Conn.; George F. Sever, New York City; Charles Henry Smith, Atlanta, Ga.; Sidney Sprout, San Francisco, Cal.; George A. Wardlaw, Oswego, N. Y.

The following associate members were transferred to full membership:

W. L. R. Emmet, New York City; Nathaniel S. Keith, San Francisco, Cal.; Alton D. Adams, Worcester, Mass.; C. E. McCluer, Richmond, Va.; J. P. Jackson, State College, Pa.

## Long Distance Transmission with Continuous Currents.

BY FRANK C. PERKINS.

ALTERNATING currents can be successfully used for transmission of power over long distances, as has been clearly demonstrated during the past few years. Some prominent electrical engineers insist that multiphase motors should always be used for long distance transmission. There is, however, no doubt that under certain conditions direct current apparatus may be made to give excellent results.

A very interesting plant has just been completed by Mr. M. Thury, of Geneva, Switzerland. Mr. Thury is electrician for Cie. de l'Industrie Electrique Geneve. At this installation about 400 h. p. is transmitted over a distance of about twenty miles, by means of continuous currents. The potential used on the line is between six and seven thousand volts.

The increasing production of the Biberist paper mills, near Soleure, was such that very soon the available motive power on the spot would be insufficient to carry the machinery required. It was, therefore, necessary to consider how to supply the additional power; and the managers of the works, advised by Prof. Denzler, of the Zurich Polytechnicum, showed much enterprise.

The Ronchatel & Frinvilliers paper mills, near Bienne, are under the same management as the Biberist mills. Their machinery is driven by water power supplied by the Suze; and between the two mills, which are about two-thirds of a mile apart, the head of water available without interfering with the working of the mills was found to be sufficient to develop 400 h. p. as an average all the year round. The distance between Frinvilliers and Biberist is about thirty kilometres, and it was decided to transmit the motive power available by means of electricity.

After having passed through the turbines of the hydraulic plant of the Frinvilliers mills, the waters of the Suze are collected into a canal and carried through short tunnels to the generating station. The head of water at that place amounts to fourteen metres; and the volume, although varying widely, according to the period of the year, is nearly always sufficient to generate 400 h. p. The generating station is located on the left bank of the river, close to Frinvilliers, and occupies a special building. A 400-h. p. turbine, built by Escher, Wyss et Compagnie, of Zurich, revolves on its vertical shaft at 120 revolutions per minute and drives, by means of bevel wheels and pinions, two dynamos, placed one on each side. These dynamos, built by Compagnie de l'Industrie Electrique Geneve, are six pole generators of the Thury system. The field magnet cores and pole pieces are made entirely of wrought iron; the armature has a Gramme winding and is very carefully insulated. At 275 revolutions per minute these dynamos generate a current of 40 amperes with 3,300 volts. They have been tested at 4,700 volts without affecting the insulation in the least. This would give 9,400 volts when the two machines are connected in series. The regular working potential is, however, but 3,300 volts

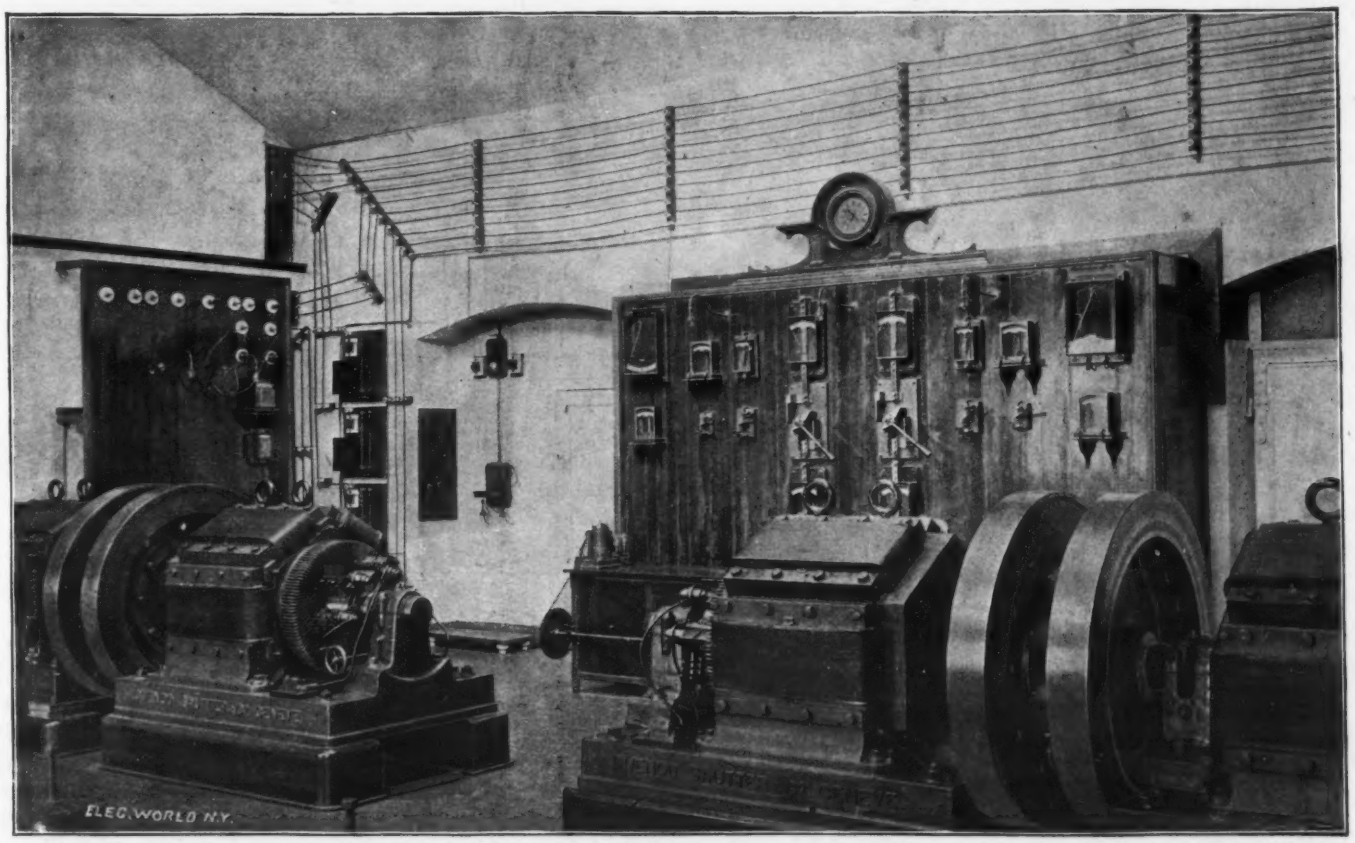



FIG. 1—DIRECT CURRENT TRANSFORMERS.

each, or 6,600 volts in series. They are insulated by means of thick layers of mica, and the bed plates are supported at a certain level above the ground by strong porcelain insulators, as shown in Fig. 2. The commutator is 75 centimetres in diameter, and is formed of 442 segments, or sections, of hard drawn copper, insulated with mica. The current is collected by 18 carbon brushes. The commercial efficiency of these machines, as tested by Prof. Denzler, reaches 93 per cent., while their weight is less than 7 1-2 tons.

They are electrically connected in series, and supply at the generator end of the line a current of 40 amperes at 6,600 volts, with a drop of 600 volts, or 10 per cent., upon the line at full load.

Bare copper conductors are used in the line construction, which are seven millimetres in diameter. The line is entirely aerial and passes through the mountainous country

lying between Frinvilliers and Biberist. From its position, it is very liable to be struck by lightning, and for this reason a number of lightning arresters have been placed on the poles besides those at the generating and receiving stations.

The two motors at the Biberist mills are exactly like the generators in construction and design. They are connected in series on 6,000 volts and deliver about 155 h. p. each at 200 revolutions per minute. The commercial efficiency of the installation from the shaft of the turbine to the motor shafts exceeds 75 per cent. at full load.

Mr. Thury has also installed a plant at Oynnax, France, which has been in operation for some time with great success. In this installation direct current transformers are used at the receiving station for reducing the potential from 2,000 volts to 120 volts.

Some of the latest types of machines for this purpose have two armatures and one set of field coils; one armature to receive the current at high potential, being driven as a motor, while the other delivers a much larger current at low potential. Other direct current transformers have two windings on the same armature and one set of field coils.

The machines designed by Mr. Thury for this purpose, shown in Fig. 1, consist practically of a generator and motor with shafts directly connected; two armatures and two separate fields being used. The motor receives the current from

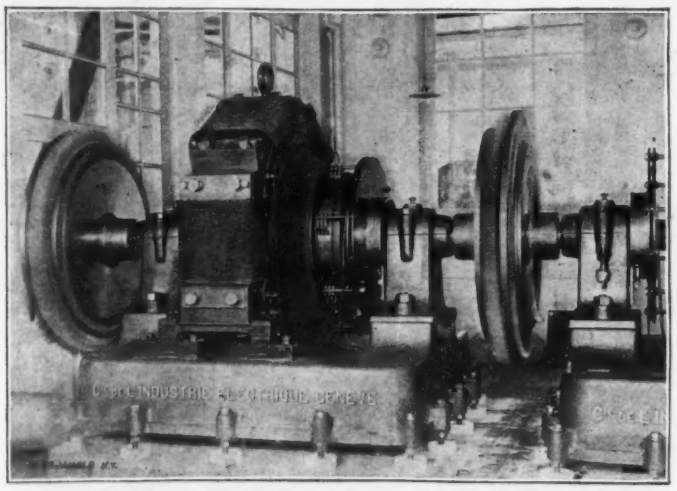


FIG. 2.—MOTOR STATION AT BIBERIST

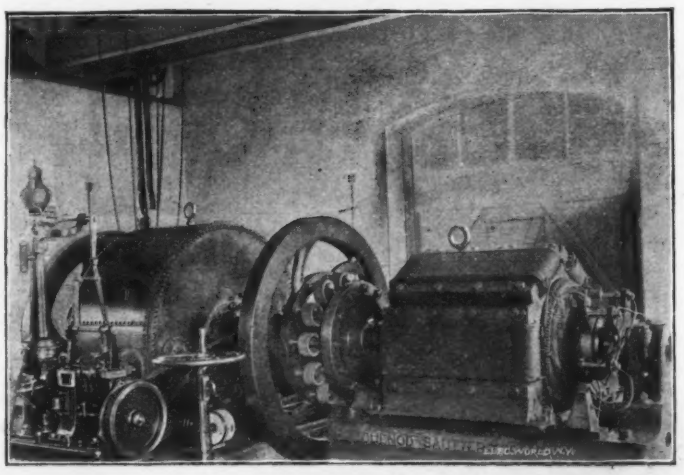


FIG. 3.—GENERATING STATION AT OYNNAX

the line at from 1,800 to 2,000 volts, and drives the generator, which delivers a current of 600 amperes at 120 volts. Each motor develops about 120 h. p.

At the generating station there are two turbines of 150 h. p. each. A generator of 105,000 watts capacity at 2,000 volts is directly connected to each turbine, as shown in Fig. 3.

The distance between the generating and receiving stations is about eight kilometres. A net efficiency of 76.2 per cent. is obtained in this transmission.

The method of connecting the generators to the turbines differs from that at Biberist in that the generator shaft and turbine shaft are directly connected and revolve horizontally, while at Biberist the turbine has a revolving vertical shaft and the generators have horizontal shafts.

### A Current Without a Difference in Potential.

In a recent after-dinner chat, the following problem arose: Suppose an air condenser be made of two metallic cylinders or rings, one slightly smaller than the other, and contained inside of it, thus forming the equivalent of the two cylindrical coatings of a Leyden jar. When charged, suppose the outer one to be fixed and the inner one to revolve around its axis; if the charges are contained, or held, in the metal, and if they remain at rest with respect to each other, that is, if they are independent of the motion of the metal, then, if a current is electricity in motion, there will be a current circulating through the revolving ring, because the charge remains at rest while the ring itself moves; there would then be a current, but there would be no difference of potential between two successive points on the ring, that is, there would appear to be a current without a difference of potential. It might be, however, that the charge in the revolving ring is not held at rest by that in the outside ring, as its path, if it moved together with the metal, would be along equi-potential lines, in other words, it might be like gravity, which does not tend to hold a body moving over a horizontal surface. In that case, it seems that the charge must move together with the metal, and, again, if an electric current is electricity in motion, this revolving ring carrying the electricity with it would be the equivalent of a current and would therefore have an effect on a fixed magnetic needle placed near it; it would again be a current without a difference of potential. In this case the effects, if they exist, would probably vary with different velocities of the ring, and it would then be possible to have such a thing as an electric current in which the electricity may be made to travel at any desired velocity. The negative result of such an experiment might at least show that a current is not electricity in motion. If the two rings are fixed and a magnetic needle be made to move in the dielectric, between them, around the same axis as that of the rings, it would seem that it should be deflected into a definite position, showing the existence of a magnetic field; this, as was understood from a recent lecture by Prof. Elihu Thomson, might explain the existence of the earth's magnetism, supposing the earth to be one plate of a condenser, the space around the earth forming the other conductor, or plate, of the condenser, the magnetic needle revolving with the surface of the earth, and therefore moving between these two changes.

### The University Extension Lectures.

The first of the course of ten lectures on electrical subjects was delivered in the Cooper Institute Building on Monday, Jan. 15, by Mr. C. O. Mailloux, the subject being "Batteries, Primary, Secondary and Thermo." The attendance was so large that almost one hundred persons had to be turned away. Hereafter the large hall in the Cooper Building will be used.

### It Is About Time.

It is noteworthy that electric light carbons are now being made in England, says the London "Electrical Engineer."

## The Saving of Copper in the Three-Wire, Three-Phase System.

BY DR. LOUIS BELL.

Within the last few months this subject has received attention from nearly every electrician of repute who is in the least interested in alternating work. Up to date the discussion has been entirely on theoretical grounds, and, indeed, this is all that is really necessary, since we may take Ohm's law for granted and the mathematical processes involved in the necessary computations are neither difficult nor complicated. The results which have been reached are in substantial accord on the point that there is in the interconnected or three-wire, three-phase system a saving of 25 per cent. over the copper required, all other conditions being equal, by the single phase or any polyphase system employing a complete circuit per phase. Inasmuch, however, as an experimental demonstration speaks more clearly to the mind of the average man than any amount of theorizing, I have recently performed some experiments for the purpose of satisfying those unfamiliar with mathematics, or stubbornly unwilling to accept mathematical demonstrations, as to the exact facts in the case. The experiments were of the simplest possible character, consisting of the transmission of energy over a three-wire, three-phase line and a single-phase line under conditions that could be most carefully controlled. Four non-inductive lines of equal length were set up leading to a small bank of lamps. The four wires were then arranged two in parallel and single-phase current at 50 cycles per second transmitted over them, the voltage at the dynamo and at the lamps and the amount of energy being carefully noted. This terminated the first part of the demonstration. Next, one of the four lines was removed and the three remaining lines used to transmit three-phased current at 50 cycles to the same bank of lamps connected in the mesh combination. The net result was as follows: With the same initial voltage and the same energy transmitted the same loss of energy was observed with the three-phase system and three wires as had previously been found with the single-phase system and the four wires. In other words, the same amount of energy was transmitted at the same loss with three-quarters the weight of conductor. The agreement with the theoretical saving of 25 per cent. was within one per cent., sufficiently close to render the demonstration complete. Now let us see what this really means; it signifies that by the use of the interconnected three-phase system we can transmit the same energy with the same loss as in the single-phase system, using but three-quarters the amount of copper. Or, it means that with the same amount of copper we can transmit more energy with the same loss, or the same energy at a higher efficiency. So far as the economy of the system is concerned, the interconnected three-phase circuit is equivalent to a rise in voltage of about 15 per cent., without, however, introducing the added strain on the insulation that would be met if the voltage of the generator were actually raised 15 per cent.

To deny the saving in the interconnected three-phase system, therefore, is equivalent to denying an advantage in increased voltage. No matter by what process the amount of copper required to meet given conditions be computed, whether by an assumed drop on the line or by rigid application of Lord Kelvin's law, the fact still remains that the three-phase system has 25 per cent. advantage over the single-phase system in the intrinsic amount of copper required to do the same work. It might be desirable in special cases not to let this saving appear as a decrease in the cross-section of the copper, but to take advantage of it in increased output or in increased efficiency. Whatever the character in which the saving in copper may appear, it is always existent, and although a Jesuitical attempt to conceal it may suppress it in a certain particular function, it will always appear somewhere and somehow as an absolute saving in the transmission system, just as must be the case with a genuine increase of voltage, and he would indeed stultify himself who would attempt to conceal the advantage of increased voltage in the electrical transmission of power.

## Relative Costs of Distribution by Different Electrical Systems With the Same Effective or Maximum E. M. F.

BY A. E. KENNELLY.

In Mr. Weaver's interesting article upon this subject, appearing in The Electrical World for Jan. 13, page 48, two of the conclusions reached appear open to some modification.

First. In the deduction by aid of Figs. 5, 6 and 7, that the triphase and diphase systems require equal weights of conductor when equal effective delivery pressures are employed, it is evident that this applies only to the delta triphase system. If the accompanying diagram of a Y triphase system be exchanged for Fig. 7, the effective pressures, as measured at the lamps, will be the same as before, but the current in each main conductor will be 2 amperes instead of $2\sqrt{3}$.

This arrangement will cause the delivery to the six lamps to be accompanied by a loss in the mains of $3 \times 2 \times 2 = 12$ watts, introducing, therefore, a saving of 75 per cent. in the copper needed for simple alternating current distribution.

On the basis of maximum E. M. F. between conductors this difference between the △ and Y varieties of the triphase system does not appear.

Second. There appears to be a flaw, although from a practical point of view an insignificant one, in the result quoted in Mr. Weaver's article for the diphase system. Fig. 6, page 48, represents three equal wires carrying three currents that are not all equal in strength. From the examination of any exaggerated case of this nature, it becomes evident that the purposes of economy can best be served by apportioning the total copper unequally among unequal currents. In this case, suppose each wire to weigh 100 pounds, making 300 pounds total weight. Then it follows arithmetically that the most economical division of this copper gives 87.9 pounds to each outside conductor (resistance 1.138 ohms), and the balance of 124.2 pounds to the return wire (resistance 0.805 ohm). The loss in delivery will now be $2 \times 3 \times 3 \times 1.138 + (3\sqrt{2})^2 \times 0.805 = 34.97$ watts instead of 36, making the relative copper expenditure 291 lbs. instead of 300. This appears to agree with Mr. Kapp's estimate.

Summing up, then, on the basis of Mr. Weaver's results, with the above slight modifications, we have for the relative loss of energy in the same weight of conductor on the different systems, or for the relative expenditure of copper for the same loss in transmission by the different systems:

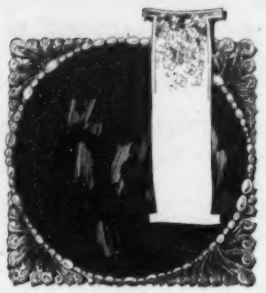
| | On basis of equal Effective E. M. F. at translating device. | On basis of equal Maximum E. M. F. between conductors. |
|---|---|---|
| Continuous current (metallic circuit) | 100 | 100 |
| Simple alternating current (metallic circuit) | 100 | 200 |
| Diphase with common return wire | 73 | 291 |
| Triphase Y system | 25 | 150 |
| Triphase △ system | 75 | 150 |

To these may be added other well-known systems for the sake of comparison:

| | On basis of equal Effective E. M. F. at translating device. | On basis of equal Maximum E. M. F. between conductors. |
|---|---|---|
| Continuous current three-wire, allowing 60 per cent. of outside copper to neutral wire. | 32.5 | ... |
| Five-wire continuous current system, allowing also 60 per cent. of outside copper to inside wires | 11.9 | ... |

## Relative Cost of Copper for Conductors.

BY CHAS. P. STEINMETZ.



N The Electrical World of Jan. 13 I read a very interesting article by Mr. W. D. Weaver on the copper economy of systems of electrical distribution, to which I would like to add a few remarks, not to dispute any of the numerical results, since obviously scientific results derived by mathematical analysis are proved beyond doubt by the innate exactness of mathematical reasoning, but merely to add a few additional remarks to this question, to which I have given a good deal of attention also.

First, instead of "effective" potential, I should prefer the expression "comparison on the basis of equality of minimum potential," since in this comparison whenever systems are compared having different potentials in their different branches—as the interlinked quarter-phase system—it is the minimum potential which is made the basis of comparison, and, further, because this basis of comparison is of interest and importance only in circuits supplying apparatus which require a definite low potential, i. e., in the low potential incandescent lighting networks.

In this case, of low potential incandescent lighting circuits, still more efficient in copper than the three-phase or quarter-phase system is the old Edison three-wire system, single-phase, or continuous current, which requires only 37.5 per cent. of the copper of the two-wire system if the neutral wire is made of the same cross-section, and 31.3 per cent. if the neutral wire is made of one-half the cross-section of the outside wire. Since by this system the potential of distribution is doubled, and since the amount of copper required in a given system is inversely proportional to the square of the potential, by the use of this system the theoretical amount of copper is reduced to one-fourth, and adding hereto the amount of copper used in the neutral wire gives the above mentioned figures.

With regard to the interlinked quarter-phase system, i. e., the quarter-phase system with common return for both phases, Mr. Weaver considers the case only where three equal wires are used. In this case the current density in the central wires or common return is 41.4 per cent. higher than in the outside wires, and therefore the disposition of the copper is not the most economical. Making the central wire of 41.4 per cent. larger cross-section than the outside, we get the most economical condition and thereby reduce the amount of copper required in the interlinked quarter-phase system in the ratio

$$1 \div \frac{3+2\sqrt{2}}{6}, \text{ or } 100 \div 97.13.$$

We get then the following table:

LOW POTENTIAL INCANDESCENT LIGHTING CIRCUITS.

COMPARISON ON THE BASIS OF EQUALITY OF MINIMUM POTENTIAL IN THE SYSTEM.

To transmit the same power over the same distance with the same loss of power, that is, with the same efficiency, the amounts of copper required are:

| | |
|---|---|
| 2 Wires—Single phase; continuous current | 100.0 |
| 3 Wires—Edison 3-wire, single-phase system, neutral 1-2 cross section | 31.3 |
| Edison 3-wire, single-phase system, neutral full cross section | 37.5 |
| Interlinked quarter-phase system | 72.9 |
| Three-phase system | 75.0 |
| 4 Wires—Four-wire, single-phase system, inside wires, 1-2 cross section | 16.7 |
| Four-wire, single-phase system, inside wires full cross section | 22.2 |
| Three-phase system, with neutral wire | 33.3 |
| Independent quarter-phase system | 100.0 |
| 5 Wires—Five-wire, single-phase system, inside wires 1-2 cross section | 10.9 |
| Five-wire, single-phase system, inside wires full cross section | 15.6 |
| Independent quarter-phase, with common neutral | 31.3 |

To compare the different systems in the simplest and most elementary manner, we have to dissolve them in their component systems of equal nature, i. e., in one-wire systems, by considering all the currents as issuing from the generator over the wires to a neutral point or centre of potential, where they neutralize each other.

Then the single-phase system of potential $e$ consists of two one-wire systems of potential $\frac{e}{2}$ each.

The three-phase system of potential $e$ between lines consists of three one-wire systems of potential $\frac{e}{\sqrt{3}}$ each.

Since the amount of copper is inversely proportional to the square of the potential, other things being equal, the amount of copper in the single phase and in the three-phase systems bears the ratio:

$$\left(\frac{e}{\sqrt{3}}\right)^2 \div \left(\frac{e}{2}\right)^2 = 4 \div 3;$$

or the three-phase system requires 75 per cent. of the copper of the single-phase system.

The interlinked quarter-phase system with three equal wires is produced from the independent quarter-phase system with four wires by making one wire the common return of both phases, whereby the loss, and therefore the efficiency, is not changed, and 25 per cent. of the copper is saved, but at the same time the maximum potential increased by 41.4 per cent.

With regard to the comparison of continuous current with the alternating current system on this basis, I beg to differ. While on the basis of the same maximum potential, i. e., the same electrostatic stress, the continuous current requires only 50 per cent. of the copper of the single-phase current, this comparison is not fair and not permissible, since a continuous E. M. F. produces not only an electrostatic stress like the alternating potential, but besides this an electrochemical stress by electrolysis, which is generally by far more severe than the electrostatic stress. It can, therefore, only be misleading to compare continuous current systems on the basis of electrostatic stress with alternating circuits, and is of no practical interest either, since at these high potentials the continuous current is out of competition anyway.

Hence, leaving the continuous current out altogether, we get by a comparison on the basis of maximum potential in the system, as it is proper with regard to the stress on the insulation and danger to life, the following results:

COMPARISON ON THE BASIS OF EQUALITY OF MAXIMUM POTENTIAL IN THE SYSTEM.

To transmit the same power over the same distance with the same loss of power, that is, with the same efficiency, the amounts of copper required are:

| | |
|---|---|
| 2 Wires—Single-phase system | 100.0 |
| 3 Wires—Three-phase system | 75.0 |
| Interlinked quarter-phase system $\frac{B+2\sqrt{2}}{4} \times 100 =$ | 145.7 |
| Interlinked quarter-phase system, with 3 equal wires | 150.0 |
| 4 Wires—Independent quarter-phase system | 100.0 |

Coming now to the editorial remarks that the factor of the line insulation is of no direct importance, since circuits have been worked successfully with 16,000 volts* and the limit of potential not yet reached, I am somewhat astonished at this statement, for, according to this reasoning, it would be inexcusable to throw away large amounts of copper on expensive lines of 3,000 volts, when by merely increasing the

*While such potentials have been used on long-distance lines, it must be understood that practical experience has by no means yet proved such potentials as successful and reliable in the long run.

potential ten fold, 99 per cent. of this copper could be saved. While it is undoubtedly true that potentials of 16,000, or even 25,000, volts can be controlled and insulated successfully, it is just as true, for instance, that in mechanical engineering pressures of 2,000 or 3,000 pounds per square inch have been handled and controlled, and yet nobody in designing a steam engine or a locomotive will think for a moment of using such pressures, though undoubtedly the boilers and engines would become smaller and more efficient thereby.

Hence, while it is possible, theoretically, to insulate for any potential whatever, practically it makes a very great deal of difference whether one has to deal with 2,000 volts or with 20,000 volts, and every increase of potential increases the difficulty of constructing and maintaining the system and reduces its reliability. Therefore, while it is theoretically possible to handle far higher potentials, and perhaps in future such potentials will even be used in practice with complete reliability, still the factor which limits and determines the maximum potential in the system is exclusively the strain on the insulation, so that in high potential circuits the comparison on the basis of equal maximum potential is not only not of secondary importance, but, on the contrary, the fundamental factor which determines the choice of the potential and the reliability of the system.

## On the Design of Electromagnets for Specific Duty.

BY E. R. CARICHOFF.

EXIGENCIES demanding the design of an electromagnet to perform a specific duty where maximum efficiency was necessary and no experimenting permitted, the writer made some preliminary calculations, and found that with certain conditions the best results were obtained by reducing the polar area, and with other conditions the best results were obtained by increasing the polar area. After going through the excellent work of S. P. Thompson on the electromagnet and not finding there or elsewhere any formulated statements showing the proper relation that should exist between the magnetic reluctance of the air gap and the iron of the magnet, the writer tabulated a lot of results and finally hit upon the following easy method of determining the relative air gap and iron reluctance in order to get the maximum work out of a given magnet, where work equals initial pull times travel.

The writer offers this with the belief that it is entirely original, although it seems strange that so simple a relation has never been pointed out before.

To explain the method, let us assume, for example, that the curve in Fig. 1, *O E C D*, represents our iron, and *O F* our air gap characteristic, and that we are working at the point *C* on said curve. Reduce the polar area *A* by $dA$, and suppose that the force is reduced for an instant by $d\mathfrak{F}$, so that the induction in the air gap is still $\mathfrak{B}$ and that in the iron is reduced by $\triangle \mathfrak{B}$. Since a tangent drawn to the curve at *C* is parallel to the line *O F*, we see that the force necessary to produce a change $\triangle \mathfrak{B}$ in the induction is the same in both iron and air gap. Therefore, if $d\mathfrak{F}$ produces in iron a change $\triangle \mathfrak{B}$, it can produce $\frac{1}{2} \triangle \mathfrak{B}$, say $d\mathfrak{B}$ in both.

It is evident that with the above assumptions

$$\frac{\triangle \mathfrak{B}}{\mathfrak{B}} = \frac{dA}{A} \text{ and } d\mathfrak{B} = \tfrac{1}{2}\, \mathfrak{B}\, \frac{dA}{A}.$$

With area $A$ and induction $\mathfrak{B}$ the pull is proportional to $\mathfrak{B}^2 A$.

With the area $(A - dA)$ and the induction $\mathfrak{B} + d\mathfrak{B}$, we have $(\mathfrak{B} + d\mathfrak{B})^2 (A - dA)$ proportional to pull.

Then

$$\mathfrak{B}^2 A <=> (\mathfrak{B} + d\mathfrak{B})^2 (A - dA) \qquad (1)$$

$$\text{if } \tfrac{1}{2}\, \mathfrak{B}\, \frac{dA}{A} <=> d\mathfrak{B}.$$

Since for this case $d\mathfrak{B} = \frac{1}{2}\, \mathfrak{B}\, \frac{dA}{A}$ the two sides of the equation are the same and the pull is the same when the polar area is $A$, and when it is $A - dA$. In the same way it can be shown that the pull is the same where the polar area is $A$ and $A + dA$.

From this we draw the conclusion that when the air gap reluctance is expressed by a line parallel to the tangent drawn at the part of the iron characteristic where we are

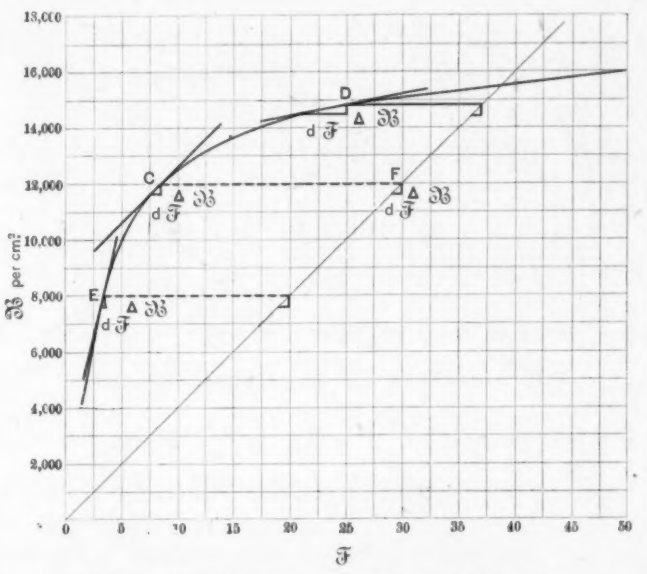



FIG. 1—DESIGN OF ELECTROMAGNETS.

working, there is no gain by either increasing or decreasing the polar area. This is evidently the condition of maximum efficiency, as we shall see from further considerations.

Keep the same characteristics and suppose our ampere turns put us at the point *D* on the iron curve. Decrease the polar area by $dA$, and for an instant the force by $d\mathfrak{F}$, so that $\mathfrak{B}$ is still the induction in the air gap. $d\mathfrak{F}$ is now much greater than before necessary to make the change $\triangle \mathfrak{B}$, so that it will produce a change in the whole circuit by an amount $d\mathfrak{B}$ referred to air gap, where $d\mathfrak{B}$ is greater than $\frac{1}{2} \triangle \mathfrak{B}$, or greater than $\frac{1}{2}\, \mathfrak{B}\, \frac{dA}{A}$. This condition makes the right-hand member of equation (1) greater than the left-hand member, showing that the pull is increased by decreasing the polar area. Increase the polar area by $dA$, keeping other conditions as above, and equation (1) shows that the pull is decreased. Therefore, if our iron curve shows that $\frac{\triangle \mathfrak{B}}{d\mathfrak{F}}$ is greater than the same function for the air gap, the air gap reluctance should be increased until the two functions are the same.

Again at the point *E* we find that $d\mathfrak{F}$ is less than in the case first cited, and if the same reasoning is followed it is found that the pull is increased by increasing the polar area.

Instead of increasing or decreasing the polar area, the same results are gotten by shortening or lengthening the air gap. When this is done, so that the function $\frac{\triangle \mathfrak{B}}{d\mathfrak{F}}$ is the same for iron and air gap, the pull multiplied by the distance is a maximum. This being the case, the best results are obtained by using the proper air gap; and if this distance is not the travel required, a lever can be used to multiply or divide with.

With these principles in view, it is easy to get the most efficient possible arrangement. It is also easy to predetermine a magnet to pull required amounts in more than one point of its travel.

By drawing tangents to all points of the iron curve and lines from the origin parallel to these tangents, and intersecting these by horizontal lines, we get the curve of proper

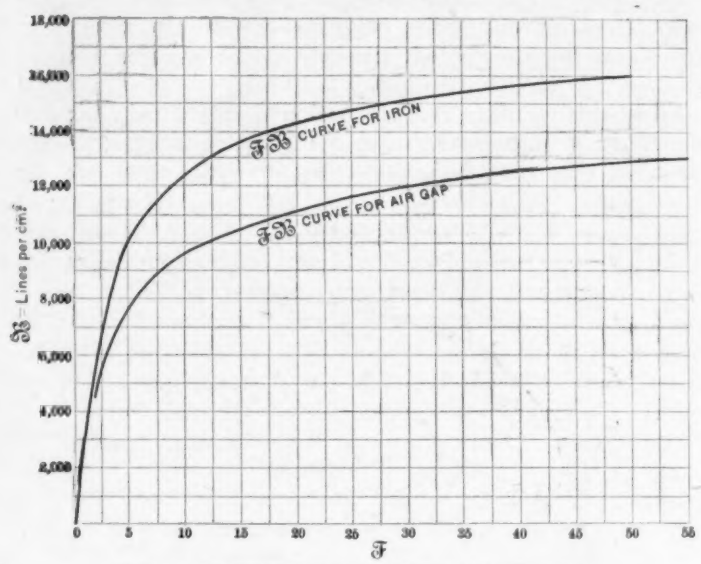



FIG. 2—DESIGN OF ELECTROMAGNETS.

air gap for all points of iron curve cut by said horizontal lines. See Fig. 2.

There are some other curves that materially reduce the labor in designing an electromagnet for a definite work.

To prove that the air gap thus determined gives the maximum amount of work, where work equals initial pull times length of gap, change $l$ by $dl$; then

$$\frac{\triangle \mathfrak{B}}{\partial \mathfrak{b}} = \frac{dl}{l}.$$

We see that for the point $F$

$$\frac{d\mathfrak{F}}{\triangle \mathfrak{B}} = \frac{d\mathfrak{F}}{\triangle \mathfrak{B}}, \text{ and}$$

$$d\mathfrak{B} = {}^1/_2 \triangle \mathfrak{B},$$

and for points to the right of $F$,

$$d\mathfrak{B} > {}^1/_2 \triangle \mathfrak{B},$$

and for points to left of $F$,

$$d\mathfrak{B} < {}^1/_2 \triangle \mathfrak{B}.$$

In the three cases the work will be proportional respectively to

$$\mathfrak{B}^2 l, \qquad (1)$$

$$(\mathfrak{B} - d\mathfrak{B})^2 (l + dl). \qquad (2)$$

$$(\mathfrak{B} + d\mathfrak{B})^2 (l - dl). \qquad (3)$$

$$(1) - (2) = + \text{ for } d\mathfrak{B} > {}^1/_2 \mathfrak{B} \frac{dl}{l}$$

$$(1) - (3) = + \text{ for } d\mathfrak{B} < {}^1/_2 \mathfrak{B} \frac{dl}{dl}.$$

## Calculating the Resistance of Wires for Alternating Currents.

BY CARL HERING.

The French journal "L'Industrie Electrique" for Dec. 25 contains an article in which some practical deductions are made from a table by Lord Kelvin, given in his inaugural address before the Institution of Electrical Engineers in 1889. The object of the deduced table is to enable one to calculate by a very simple computation the effective resistance of circular wires when alternating instead of direct currents are used. It gives the factors by which the ordinary resistance of a wire must be multiplied in order to give its effective resistance for alternating currents. The principle on which the table is based is described briefly in an abstract of that article contained in The Electrical World's Digest of last week. But as the figures in the first column of the table are for diameters given in centimetres, a reduction must be made if the diameters are given in mils. In order to avoid having to make this reduction, the writer has transformed the first column, so that diameters in mils, that is thousandths of an inch, may be used. The table thus reduced is as follows:

| Circular mils × frequency. | $k$. | Circular mils × frequency. | $k$. |
|---|---|---|---|
| 0 | 1.0000 | 198,412,800 | 1.6778 |
| 3,100,200 | 1.0000 | 251,116,200 | 1.8628 |
| 12,400,800 | 1.0001 | 310,020,000 | 2.0430 |
| 18,291,180 * | 1.0100* | 375,124,200 | 2.2190 |
| 24,336,570 * | 1.0200* | 446,428,800 | 2.3937 |
| 27,901,800 | 1.0258 | 793,651,200 | 3.0956 |
| 49,603,200 | 1.0805 | 1,240,080,000 | 3.7940 |
| 77,505,000 | 1.1747 | 2,790,180,000 | 5.5732 |
| 111,607,200 | 1.3180 | 4,960,320,000 | 7.3250 |
| 137,958,900 | 1.4920 | | |

The table is calculated for a specific resistance of 1,597 C. G. S. units.

The increase in resistance referred to depends on the diameter and on the frequency, but is the same when the product of the frequency and the square of the diameter is the same. To use the table, multiply the frequency (in periods per second) by the square of the diameter in mils, that is, by the cross-section in circular mils, and find the number nearest equal to this in the first column, then the corresponding value of $k$ in the second column will give the factor by which the resistance in ohms for direct currents must be multiplied in order to give the effective resistance for alternating currents of that period in cylindrical conductors of that diameter. If the diameter is given in inches instead of mils, divide the numbers in the first column by one million.

To take an example, let the frequency be 125 and the diameter of the wire be 460 mils (No. 0000 B. & S.); squaring the diameter and multiplying by the frequency gives 26,450,000; the nearest number to this, in the first column of the table, is 27,901,800, and the corresponding value of $k$ is 1.0258; if the resistance of this wire is two ohms, the effective resistance for these alternating currents will then be 2.0516 ohms.

For values not found in these columns it is sufficiently accurate to take the nearest one or to interpolate by proportion.

It will be seen from the fourth value, which is interpolated, that, if the frequency is 125, the differences between the two resistances is only 1 per cent. for wires of about 382 mils diameter, which is slightly larger than a No. 00 B. & S. wire. For that frequency and for wires smaller than this, the error in omitting this correction will therefore be less than 1 per cent. The product of the diameter and frequency has also been interpolated for a correction of 2 per cent.

The number of decimal places in the original table has been retained, although in the opinion of the writer it is not necessary to have the values of constants to an accuracy of one-thousandth of one per cent. in dealing with frequencies and diameters, neither of which can be measured and depended upon to anything approaching this degree of accuracy.

## Telephone Wires in Norway.

London "Electricity" states that the wire employed for telephonic purposes in Norway, with the exception of Christiania and Bergen, is made of Swedish iron, or steel, and is 2 millimetres in diameter. At Christiania bronze wire of 1.25 millimetres diameter and bimetallic wire (steel and copper) 1.9 milimetres, is also used.

* Interpolated, giving constants for an increase of 1 and 2 per cent

## Is Telephonic Induction Electrostatic or Electromagnetic?—II.

BY F. W. DUNBAR.

ACCEPTING the explanation of the discrepancy between the theoretical and observed values as the correct explanation, we are justified in the statement that the actual value of the effective capacity of the conductors during conversation, when the reversals take place far too rapidly to allow the bound charges on the high resistance cross-arms to fully gather and dissipate, will always exceed 50 per cent. of their capacity to ground by a constant amount equal to one-half the direct air capacity between them. And following directly from this the difference in the effective capacity between any two wires upon the pole line is equal to one-half the direct capacity between these two wires.

This gives a value of (.000055 − .000037 = .000018) mfd. per mile for the difference in capacity of 1 on 3 and 4 and a value of (.000110 − .000055 = .000055) mfds. per mile for the difference in capacity of 2 on 3 and 4; making a resulting difference in capacity of 1 and 2 on 3 and 4, when 1 and 2 form the disturbing circuit and 3 and 4 form the disturbed circuit of .000037 mfds. per mile; a value less than 1-3 per cent. of the actual capacity of either conductor to ground. Thus the electrostatic induction between two circuits most favorably situated for maximum cross talk would be practically negligible. But for purposes of comparison we will suppose that the effective capacities in practice are the values secured by experiment, although we know discrepancies exist in these results and that the only obvious and plausible explanation of these discrepancies will reduce the results to their theoretical values within the limits of accuracy of the experiments.

The difference in mutual capacity between circuit (1, 2) and the conductors 3 and 4 (constituting the disturbed circuit) may be at once approximated from the actual observed values recorded in Table II.

Thus the mutual capacity of

$$\begin{aligned} +1 \text{ on } 3 &= +.331 \\ +1 \text{ on } 4 &= +.324 \\ -2 \text{ on } 3 &= -.370 \\ -2 \text{ on } 4 &= -.331 \\ & \quad .039, -.007 \end{aligned}$$

giving a resultant difference in capacity of 1 and 2 on 3 and 4 of —.032, or —.00073 mfd. per mile.

This value, although twenty times the probable actual value, is yet but 5 per cent. of the capacity of either wire to ground.

These wires chosen are evidently those upon which the difference in capacity would be a maximum according to observed values, and are consequently the most favorably situated for possible electrostatic induction.

It may be remarked that had 5 and 6 been chosen for the disturbing circuit the resulting disturbance would be found to be but about 15 per cent. of the disturbance produced by the pair chosen (1 and 2)—a result not at all in accordance with practice, and again indicating a discrepancy between the observed and true results.

The effect of this difference in capacity between the conductors of the disturbing and disturbed circuits will be to induce a current in the disturbed circuit such that the $dq$ at any point ($x$) will be equal to the product of the potential of the disturbing circuit $e$ at that point, and this resultant capacity $c_0$,

$$\text{or that } dq = c_0\, dx\, e$$

$$\text{and } di_0 = \frac{d}{dt}(dq) = c_0 \frac{de}{dt}\, dx.$$

The value of $e$ is given by

$$e = \frac{E}{e^{pl} \mp 1}\left[e^{pl-px}\sin(\omega t - ax) \pm e^{px}\sin(\omega t + ax)\right]$$

$$\text{hence } \frac{di_0}{dx} = \frac{c_0 E\omega}{e^{pl} \mp 1}\left[e^{pl-px}\cos(\omega t - ax) \pm e^{px}\cos(\omega t + ax)\right]$$

$$\text{or } i_0 = -\frac{c_0}{c}\frac{E\sqrt{c\,\omega}}{\sqrt[4]{R^2 + 2^2\omega^2}}$$

$$\left[\frac{e^{pl-px}\sin\left(\omega t - ax + \tan^{-1}\frac{p}{a}\right) \pm e^{px}\sin\left(\omega t + ax + \tan^{-1}\frac{p}{a}\right)}{e^{pl} \mp 1}\right]$$

where $i_0$ is the current in the disturbed circuit, and $c$ is the capacity to ground of either of the disturbing wires.

$$\text{The expression } -\frac{E\sqrt{c\,\omega}}{\sqrt[4]{R^2 + 2^2\omega^2}}$$

$$\left[\frac{e^{pl-px}\sin\left(\omega t - ax + \tan^{-1}\frac{p}{a}\right) \pm e^{px}\sin\left(\omega t + ax + \tan^{-1}\frac{p}{a}\right)}{e^{pl} \mp 1}\right]$$

is the value of the current in the disturbing circuit. The value of the current in the disturbed circuit may then reach a value of $\frac{c_0}{c}$ or 5 per cent. of the disturbing current. But we know that upon two such circuits of any considerable length it is a difficult matter to determine at the receiving end upon which circuit the transmitting is being done.

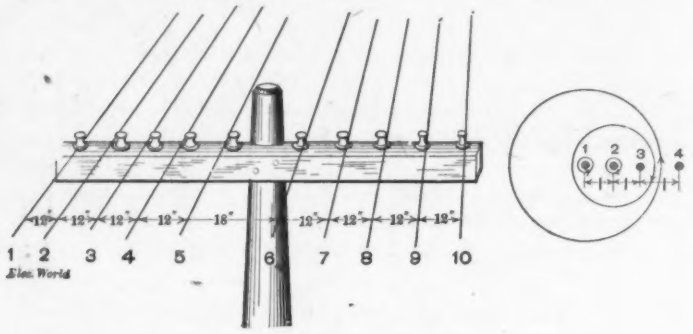
Therefore, upon two circuits most favorably situated for electrostatic induction we have failed to account for the cross-talk. If we had used the theoretical values which, in view of the indications from the experimental results, would seem justifiable, we would have found the disturbing current 300 times greater than the induced current, or that the cross-talk due to the electrostatic induction is negligible.

Up to this point pole lines alone have been discussed. The results of several hundred observations upon the electrostatic capacity of underground cables uniformly indicate that the mutual capacity of any two wires in the cable, which are not directly adjacent, is a practically constant quantity and exceeds 50 per cent. of the capacity to ground by an amount less than 1 per cent., or about the limit of accuracy of the experiments.

The capacity of one wire to its mate, however, varies in different cables from 55 per cent. to 59 per cent. of the capacity to ground, while the capacity of one wire to an adjacent wire, but not its mate, varies from 51 per cent. to 52 per cent. of the capacity to ground. The unexpectedly large excess over 50 per cent. of the mutual capacity of one wire to its mate is undoubtedly due to the compression of the insulation caused by the twisting together of the two wires of each pair. This would of course bring the two wires of each pair unduly near together, and hence increase the direct capacity of one wire to its mate. The slight excess over 50 per cent. of the capacity to ground of one wire to an adjacent one, not its mate, is fully accounted for by the direct capacity of these two wires. But between any two wires not directly adjacent the direct capacity plays such a small part that it can only be detected by experiment with apparatus capable of an accuracy far greater than one per cent. Therefore, the actual observations on the capacity of cables corroborate the statement we felt justified in making from the results of the tests on line wires, i. e., that the difference in

mutual capacity between any two conductors (not adjacent, in cables) is negligible, being less than one per cent. of the capacity to ground on both cable and line conductors. Accepting this statement, the possibility of accounting for cross-talk by electrostatic induction vanishes.

The magnitude of the electromagnetic induction depends upon the number of lines of force produced by the disturbing current, which thread through the disturbed circuit. This value is readily obtainable from the value of the current flux outside a wire between the limits of $3\,l$ and $2\,l$ where $l$ is the distance separating the wires (30 cm).




FIGS. 5 AND 6.

Thus, for copper wire in air the current flux linkage between 1 and 3 and 4 will be $2 \log_{\varepsilon} \frac{3\,l}{2\,l} = .8108$ per unit current in 1, and between 2 and 3 and 4, $2 \log_{\varepsilon} \frac{2\,l}{l} = 1.3862$ per unit current in 2. Therefore, the total or resultant linkage per unit current, or the induction, is .5754 per centimetre, $= \frac{.5754 \times 161{,}000}{10^9} = .0000925$ henry per mile. Similarly, the inductance in henrys per mile for either 1 or 2 upon its own circuit is 0.00165.

The induced E. M. F. upon the disturbed circuit (3 and 4) is at any point equal to $L_0 \frac{di}{dt}$ where $L_0 = .0000925$ and $i$ = current in the disturbing circuit.

The value of this current at any point, $x$, and time, $t$, is

$$i = \frac{-E\sqrt{C\omega}}{\sqrt[4]{R^2 + L^2\omega^2}\,(\varepsilon^{pl} \mp 1)} \left[ \varepsilon^{pl-px} \sin\left(\omega t - ax + \tan^{-1}\frac{p}{a}\right) \pm \varepsilon^{px} \sin\left(\omega t + ax + \tan^{-1}\frac{p}{a}\right) \right]$$

$$\text{hence } de = L_0\,dx\,\frac{di}{dt} = \frac{-L_0\,dx\,E\sqrt{C\omega}\,\omega}{\sqrt[4]{R^2 + L^2\omega^2}\,(\varepsilon^{pl} \mp 1)} \left[ \varepsilon^{pl-px} \cos\left(\omega t - ax + \tan^{-1}\frac{p}{a}\right) \pm \varepsilon^{px} \cos\left(\omega t + ax + \tan^{-1}\frac{p}{a}\right) \right] \quad (1)$$

$$\text{and } e = \frac{L_0\,\omega}{\sqrt{R^2 + L^2\omega^2}} \left[ \frac{E}{\varepsilon^{pl} \mp 1} \left\{ \varepsilon^{pl-px} \sin\left(\omega t - ax + 2\tan^{-1}\frac{p}{a}\right) \mp \varepsilon^{px} \sin\left(\omega t + ax + 2\tan^{-1}\frac{p}{a}\right) \right\} \right] \quad (A)$$

where

$L$ is the inductance of a circuit upon itself in henrys per unit length.

$L_0$ is the inductance of the disturbing upon the disturbed circuit in henrys per unit length.

$C$ is the capacity of a single conductor to ground in microfarads per unit length.

$R$ is the resistance of a single conductor in ohms per unit length.

$\omega = 2\pi n$ where $n$ = number of alternations per second.

$E$ = maximum positive value of the impressed E. M. F.

$i$ = current, $t$ = time, $x$ = distance, $e$ = potential, $\varepsilon$ = Napierian base (2.718+)

also $p = \sqrt{C\omega}\,\sqrt{(R^2 + L^2\omega^2)^{1/2} - L\omega}$,

and $a = \sqrt{C\omega}\sqrt{(R^2 + L^2\omega^2)^{1/2} + L\omega}$.

The expression in the brackets is the expression for the value of the E. M. F. in the disturbing circuit at any time, $t$, and distance, $x$, with the exception of the phase which is advanced by $2\tan^{-1}\frac{p}{a}$, the total induction in the disturbed circuit represented by equation (A) between the limits $x = \frac{l}{2}$ and $x = 0$, is

$$E_0 = \frac{L_0\,\omega}{\sqrt{R^2 + L^2\omega^2}}\,E \sin\left(\omega t + 2\tan^{-1}\frac{p}{a}\right).$$

This expression is $\frac{L_0\,\omega}{\sqrt{R^2 + L^2\omega^2}}$ times as great as the value of the E. M. F. impressed upon the disturbing circuit and is advanced in phase by $2\tan^{-1}\frac{p}{a}$.

But in the disturbing circuit this E. M. F. is impressed wholly at one point, the origin, while in the disturbed circuit the induction takes place throughout the entire circuit, as represented in equation (1).

The solution for the distribution of current in the disturbed circuit could be found by the same method employed in the solution for the current in the disturbing circuit, using for the value of the impressed E. M. F. that given by equation (A) instead of $E \sin \omega t$; but although this would give us the value of the cross-talk at any point in the circuit, the solution is laborious and an approximation is readily effected.

The values of the coefficient $\frac{L_0\,\omega\,l}{\sqrt{R^2 + L^2\omega^2}}$ for the line wires under discussion are

for 160 alternations per second .018
for 320 alternations per second .031
for 640 alternations per second .046

Thus, if the induction on the disturbed circuit took place wholly at the origin, and consequently the current should follow the same law of distribution as upon the disturbing circuit, the cross-talk would be, for 320 alternations per second, .032 times as great as the disturbing current and maintain a constant ratio to it throughout the entire circuit length.

If, however, the induction be assumed to take place entirely at the distant end, the cross-talk would, at the distant end, have a value .031 times as great as the disturbing current at the origin. In practice the current at the origin may be ten or even 100 times the value at the distant end on the disturbing circuit; therefore, in this case the cross-talk might equal or exceed the disturbing current.

The true value, of course, lies somewhere between these two extremes.

Thus, although both the disturbed and disturbing currents decrease with an increase in distance from the origin, the disturbed, or induced, current decreases much more slowly on account of its distributed induced E. M. F., and consequently its ratio to the disturbing current, or the cross-talk, increases with the distance from the origin and with the length of circuit. These results are substantiated by practice, and in themselves form a strong argument against the electrostatic theory, in which, as we have seen, the cross-talk is independent of the distance from the origin and the length of circuit.

The coefficient $\frac{L_0\,\omega}{\sqrt{R^2 + L^2\omega^2}}$ shows us that until the rate of alteration is sufficient to render $L\omega$ greatly in excess of $R$, the cross-talk increases with an increase in pitch. Thus, on the lines under discussion pitch 320 (representing the fundamental of the average female voice) will be heard by cross-

talk 70 per cent. better than pitch 160 (representing the fundamental of the average male voice).

This explains why the female voice is unduly prominent when heard by cross-talk, and also why voices heard by cross-talk are apparently raised in pitch. The effect is especially noticeable in cables where $R$ is greatly in excess of $L\omega$, and consequently the cross-talk varies directly with the pitch.

According to the electrostatic theory the cross-talk, as we have seen, is independent of the rate of alternation, a result substantiated by facts.

These equations have neglected the back influence of the disturbed upon the disturbing circuit, which should be taken into account, as in dealing with the ordinary induction coil, but as the influence of this induction would be simply to reduce the value of the disturbing current and also prevent the cross-talk ever exceeding the disturbing current, its effects have been omitted.

However, we may draw the conclusion that the presence of transpositions upon line wires, besides decreasing the cross-talk, allows the current in the transmitting circuit to attain a higher value than it would were such transpositions absent.

In the above equations also the effect of the receiving instruments upon the disturbed circuit has been omitted. While playing little part in a disturbed circuit of considerable length, their effect is all important on short lines and greatly reduces the value of the induced current, especially at the portion of the circuit where introduced.

The disturbed circuit has been assumed to be similar in all respects to the disturbing circuit and both used as closed metallic circuit loops.

In conclusion, to bring out more clearly the point I have attempted to make, the difference in the electrostatic capacity of a certain wire in a given cable measured first with another wire in the same cable, but not directly adjacent, and second with a wire in another similar cable separated a distance of one mile from the first cable, can only be detected by a careful test with delicate apparatus, and would in general be less than one per cent. Yet we know that cross-talk will exist between the two conductors in the same cable (assuming the pairs are not twisted) and will not exist between the two wires which are separated a distance of one mile. The electrostatic theory offers no explanation of this fact.

## Non-Infringing Telephone Transmitters.

BY WILLIAM A. ROSENBAUM.

THE telephone situation, so far as affected by the fundamental patents, was discussed in an article in The Electrical World of the 6th inst., and the fact was pointed out that after Jan. 30, 1894, there will be but one of the fundamental patents left, the others all having become void by reason of expiration of the regular term, or by limitation due to foreign patents. The single remaining patent referred to was the Berliner patent of Nov. 17, 1891. I also pointed out the fact that a suit by the Attorney General is now in progress for the nullification of the Berliner patent on various grounds, which appear to be ample for the purpose intended.

A recent writer on this subject, with an apparent intention of bolstering up the Bell telephone monopoly, gives as his opinion that there are also strong grounds for believing that the Edison transmitter patents will be finally sustained. This opinion, however, is likely to prove quite as erroneous as another statement in the same article that "previously patented in a foreign country" should be taken to mean previously applied for in a foreign country. What the writer should have said; Previously patented in a foreign country should be taken to mean patented in a foreign country previous to applying for patent in this country. Any one at all familiar with the subject knows that in foreign countries the date of application is the same as the date of the patent.

But regardless of the result of the suit to annul the Berliner patent and regardless also of the final disposition of the Edison patent, it appears to me that the larger part of the disturbance and anxiety which exists concerning these patents is needless, and it would seem that the safest and speediest way of relief from all such anxiety is in the use of a transmitter which does not infringe either of the patents, if such is possible.

The Berliner patent contains six claims, of which the first two are the most important. The first claim covers electrodes in constant contact, the pressure between which is varied by the sound waves. The second covers electrodes in constant contact, the pressure between which is varied by a diaphragm acting upon them, the diaphragm being moved by the sound waves.

The first claim is a little broader than the second, because it is not confined to the use of a diaphragm, while the second is so limited. The vital feature is the use of electrodes in constant contact. If it is impossible to construct a practical microphone without using electrodes in constant contact, then of course the public must wait until the Berliner patent is nullified, either through the pending suit or by the expiration of the term of the patent.

The broad Edison patent contains one claim which covers a diaphragm with one or more carbon points resting against it, the resistance being altered by the variations of pressure of the diaphragm against the point or points. Neither electrodes in constant contact nor a diaphragm exerting various pressures upon an electrode are absolutely essential to a successful transmitter. In the first place, the Bell receiver makes a very good transmitter, and, no doubt, will be used largely on short lines. Again, there are various forms of transmitters patented which do not comprehend the features of the Berliner and Edison claims.

For instance, in 1878, a patent issued showing a pair of electrodes separated from each other and immersed in water. The vibrations of the diaphragm vary the distance between the electrodes, and therefore the electrical resistance of the water between them. In the same year another patent was issued, in which the movements of the diaphragm were communicated to a pivoted lever, which in turn made contact with more or fewer of the terminals of a rheostat and thereby cut resistance into and out of circuit in proportion to the amplitude of the vibrations of the diaphragm.

The Cuttriss transmitter has no electrodes at all. The variable resistance is a small spiral spring of carbon, the convolutions of which are opened and closed by the movement of the diaphragm.

These patented forms are cited to show that it is possible to construct a practical transmitter without infringing the Edison or Berliner patents. It is not intended to convey the impression that these various forms are open to the public. But they are sufficient to point out lines upon which inventors may work with an expectation of producing a practical transmitter which does not infringe the two patents referred to.

## The Chicago Congress.

Our London contemporary, "Electrician," says: "The gathering at Chicago was distinguished from most of the previous meetings of the same kind by its thoroughly representative character, the high order of merit of the papers read, and the increasingly large share that America, hitherto remarkable chiefly for its practical applications of scientific discoveries, is taking in the pure science work of the world."

## The Theory and Design of the Closed-Coil, Constant-Current Dynamo.*

BY HENRY S. CARHART.

CONSTANT current dynamos for arc lighting have been in practical use for the past fifteen years. Most of the public lighting by arc light service has been done with dynamos of the open-coil type. They secured the field at an early day in the development of this branch of electrical industry through the inventive genius of Mr. Charles F. Brush and the splendid ability of his business associates. This success practical use for the past fifteen years. Most of the public lighting by arc light service has been done with dynamos of the open-coil type. They secured the field at an early day in the development of this branch of electrical industry through the inventive genius of Mr. Charles F. Brush and the splendid ability of his business associates. This success was repeated a little later by the equally brilliant achievements of Profs. Thomson and Houston and the phenomenal management of the company formed to exploit their patents. Aside from any question of inferiority, it is therefore easy to see why the closed-coil dynamo for constant currents has remained so long in the background. It has not received the attention to which it is justly entitled, and has not been investigated with the thoroughness and skill which it merits.

It is not my purpose to draw any comparisons whatever between open and closed-coil armatures. The former is entitled to that consideration which long continued and satisfactory service in public and private illumination has earned for it. But the latter is making its way into public favor, and it has certain peculiarities which make it an interesting subject for study. If I were to draw attention in this paper to comparisons between dynamos of different type, it would be between those for constant potential and those designed for constant current, both with closed-coil armatures. For in almost every particular the latter is diametrically opposite to the former. The one is designed to give a constant potential; the other a constant current. One is shunt or compound wound; the other series wound. In the one the resistance of the armature is as low as possible in comparison with the field; in the other the armature resistance is relatively large compared with the field. The one has a sensitive field and is worked below the saturation point; the other should have a stable field which is worked well up on the saturation part of the curve of magnetization. Ideally the characteristic of the one is a horizontal line; that of the other, a vertical line. In the constant potential machine the brushes are set only slightly in advance of the theoretical neutral line or plane; in the constant current dynamo the brushes may be at any point on the commutator, according to the load, while the neutral plane remains fixed. When the load decreases with the one the brushes, if moved at all, are rocked backward for sparkless commutation; when the load decreases with the other the brushes are rocked forward for minimum sparking, or even sparkless commutation and constancy of current. When the load increases on the one it governs by an increase of induction from an increasing field; when the load increases on the other it governs by decreasing the counter E. M. F. in the coils between the brushes and the neutral plane. In the one armature reaction is purposely reduced to the smallest dimensions; in the other it is purposely made of considerable dimensions. In these comparisons it is assumed that the speed is constant in both cases. If some of these statements are not self evident they will be supported, I hope, by subsequent portions of this paper.

By neutral plane is meant a plane passing through the axis of the armature and so situated with reference to the poles of the field magnet that when a coil of the revolving armature is carried across it the E. M. F. generated changes direction. This plane intersects the armature in a straight line, but it may broaden out more or less into a surface of small lateral dimensions.

The plane of commutation is a plane passing through the armature axis and the points of contact of the brushes on the commutator. It is the plane joining the poles of the armature considered as an electromagnet. This latter plane of course shifts with the brushes, since the poles of the armature are the points at which the current enters and leaves the armature, and these are necessarily the points or surfaces of contact of the brushes with the commutator, assuming that the connections from the armature to the commutator run directly out parallel to the shaft. To state the proposition now under discussion in the form of a question, Does the neutral plane shift when the brushes are shifted forward or backward? If we were to make answer from the assumption that the resultant of two impressed magnetizations or magnetomotive forces may be obtained in the same manner as the resultant of two forces by means of the triangle of forces, we should probably conclude that the neutral plane rotates forward with a forward movement of the brushes. But experiment along several different lines shows that this conclusion is in error. If we were to apply to the solution of this problem the principles derived from constant potential machines, we should be forced to the conclusion that, to maintain sparkless commutation at the brushes, the lead of the brushes beyond the neutral plane should be constant, since the current remains constant; and therefore that any attempt to govern for constant current by rocking the brushes must be attended by destructive sparking, unless at the same time the field is greatly modified. But these conclusions are also erroneous. We must therefore first establish the facts and then make a theory to fit them.

The fixed position of the neutral plane I have determined on a ten-light machine in two different ways.

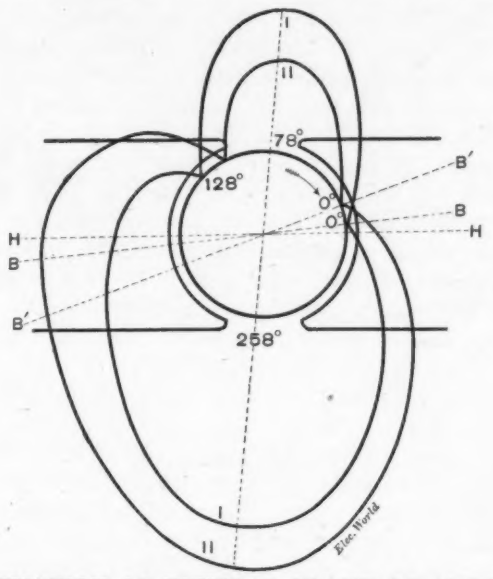
First Method.—Four turns of No. 16 silk covered magnet wire were wound around the armature ring as an exploring coil. One end of this coil was soldered to a copper band or ring fastened on the commutator and insulated from it by several thicknesses of mica. The other end was soldered to a piece of brass let into a fibre collar placed around the commutator. One extra brush was fastened to one of the main brush holders and rested on the copper band. The other extra brush rested on the fibre collar, and could be attached to any point of a circular scale made concentric with the commutator. A twisted cord ran from these two brushes to a telephone at some distance. When the dynamo was running the movable brush, which rested on the fibre and made contact with the brass strip every revolution, was moved around the circle till a minimum sound was heard in the telephone. The exploring coil was then on the neutral plane at the same instant when the brush made contact with the strip. Motion of the brush either way caused the sound to increase in loudness. The position of the exploring coil for minimum sound was to be found about five degrees in advance of the normal plane intermediate between the pole pieces; and its position did not change from full load to no load, as far as could be detected by this method.

Second Method.—To the brush holders was attached an insulating ring slotted on the periphery at every ten degrees on a milling machine. It was made as nearly concentric with the commutator as possible. A third brush holder was placed in the successive slots, and the potential difference be-

* A paper read before the Electrical Section of the Franklin Institute.

tween it and one main brush was measured in its several positions. These measurements gave the integrated P. D. between the main brush and successive points on the commutator all the way round the circle and back to the starting point. This was done with no load or nearly short circuit, with a load equivalent to three lamps, and finally with a load equivalent to nine lamps, the current being ten amperes in each case.

The results in the first two cases are plotted round a circle




DETERMINATION OF NEUTRAL PLANE OF ARC DYNAMO.

in Fig. 1. Positive values, or those in which the potential of the third brush was higher than that of the main positive brush, are set off outside the circle in the upper part of the figure; while negative values are set off outside in the lower section of the diagram. The direction of rotation is clockwise. With no load the highest positive potential was about 78 degrees behind the positive brush. From this point it fell again, and at 128 degrees it was the same as that of the positive brush. For all the coils between 0 degrees and 128 degrees the integrated positive and negative E. M. Fs. exactly equal each other. The neutral plane falls evidently 78 degrees behind the brush, or the brushes may be said to have a load of 78 degrees, with no increase in sparking. A negative maximum occurred at about 260 degrees, and the potential difference between the positive and negative maxima was 644 volts. The same P. D. was found by direct measurement when two extra brushes were set at these points.

With a load equivalent to three lamps the brushes were rocked back 15 degrees to bring the current to ten amperes. Hence the zero of this curve begins 15 degrees back from the zero of the first curve. Again the observations are plotted and the positive maximum falls at the same place on the circle, and therefore at the same place on the commutator. The two maximum points are at about 65 degrees and 245 degrees from the positive brush, and the two potential differences are 168 and 456 volts. Their sum this time is 624 volts, a little less than with no load. With the highest load carried the brushes were rocked backward about 50 degrees further, and the lead was then about 15 degrees. The extreme P. D. obtainable this time did not exceed 600 volts. So far as can be discovered from these curves the neutral plane remains fixed, while the brushes move round the commutator to adjust to a constant current. I find no evidence in them that the forward movement of the brushes to control the current causes the neutral plane to move with them. As the brushes advance with a diminishing external load they put between them and the neutral plane an increasing number of armature turns generating counter E. M. F.; and it is a striking fact that, when the field coils are not cut out, the back turns on the armature cut down the P. D. between the brushes, not by a counter magnetomotive force apparently, but by counter electromotive force; for the maximum P. D. to be found on the commutator is no lesss on no load than on full load, showing that at least as many lines of force traverse the armature core with the brushes far forward and with many back armature turns as with the brushes in the position for the maximum load and with the back turns reduced to a minimum.

(To be continued.)

## Prof. H. A. Rowland vs. the Cataract Construction Company.

The suit brought by Prof. Henry A. Rowland, of Johns Hopkins University, against the Cataract Construction Company, of which mention was made in these columns last week, has proved to be one of the most interesting which has appeared in the courts for some time, although its relative importance, as far as the public is concerned, is, of course, not great. Prof. Rowland had sent in a bill for $10,000 for his services as an expert in connection with the work of the company and had received from the Cataract Construction Company a check for $3,500 in payment therefor. He then brought suit against the company for $30,000 on the ground that his first estimate of the value of his services was too low.

The case came up in the United States Circuit Court for the Southern District of New York before Judge Shipman and a jury on Jan. 17. The plaintiff was represented by Wise & Flannagan and W. L. Marbury, while Messrs. Bangs, Stetson, Tracey & McVeigh and Joseph H. Choate looked after the interests of the defendants.

Prof. Rowland was first called to the witness stand, and after stating that he had held his present position of professor of physics at the Johns Hopkins University since 1876, gave a brief outline of his career and work, from which it appeared that he began his studies in electricity and magnetism at the early age of ten years, and that they therefore have covered a period of over thirty years. He stated that he was first connected with the Cataract Construction Company in 1889. At that time he took up for them the question of electrical transmission of power at Niagara and received for his services the sum of $1,000. He then showed what an immense undertaking the work, which was the subject of the present controversy, was, and that it had occupied his time constantly for seven hours a day for over six months. The question of determining the proper frequency or period he regarded as the most important, for this decided whether arc or incandescent lighting was possible, and determined the number of revolutions of the motor, number of poles, size of transformers, etc. He had recommended a period of 33, provided they were willing to give up arc lighting, and that which was adopted was 25, which was very near his recommendation. The weight of the moving parts was perhaps the next most important question, and he had recommended 25 tons with an armature 10 feet in diameter; he believed this recommendation had been practically adopted. He had also advised the use of step-up transformers, which feature was also part of the present plans. He further suggested artificial cooling of the transformers, and he believed that this device was an origination of his own and had not been before used. He had objected seriously to making an adverse report on the work of a brother physicist, Prof. Forbes, but a report had been insisted upon by the officers of the Cataract company.

In one of his letters Prof. Rowland had spoken of himself as the "acknowledged first physicist and electrician in this country," and the defense brought this statement unpleasantly into prominence. In answer to a question as to what practical work of this nature he had previously done, he stated that he had been employed by the Sprague Railway Company

some years ago on work which he shared with Dr. Louis Duncan, and which occupied altogether, as he remembered, somewhat less than two months and for his half of which he had received $1,000. The United States Government had also employed him in regard to a report on the placing of electric wire underground in the District of Columbia, and for this work, which covered a period of four or five months, he received about $4,000. The Weems Electric Railway Company some years ago had also employed him, together with Dr. Duncan, and for this work, which took about one week, he received $500. He stated that his salary at the Johns Hopkins University was $5,000 per annum, or about $30 per hour, as he lectured about one-half hour twice a week.

In reply to inquiries as to his acquaintance with various members of the Niagara Commission, Prof. Rowland gave some interesting estimates of the prominent men connected with that body. Sir William Thomson he acknowledged to be the greatest physicist and electrician in Europe, and presumably in the world. Coleman Sellers, he said, had no standing as an electrician; he was a mechanical engineer, and of this Prof. Rowland did not pretend to judge, although in reply to a question he declined to name any one who stood higher. In regard to Mascart he stated that his standing as a physicist was very good, but not the highest. Being asked who stood higher, except Sir William Thomson, he replied as follows: "Sir William Thomson is very eminent, and Stokes is most eminent, and Lord Rayleigh is most eminent, and J. J. Thomson, a young man, I think is superior." He also added that he could give a longer list than these whom he regarded as superior to Mascart. Col. Turrettini he had never heard of, except in conection with the commission. Prof. Unwin's standing he thought very high. He stated that he had done no work during the period in which he had been engaged in preparing the report for the Cataract Construction Company, except the preparation of two scientific articles published in The Electrical World.

A deposition from Dr. John Hopkinson was read in which he stated that his usual charges for work of this character was three guineas an hour. Speaking of Prof. Rowland, he said that his position was the very highest, and his contributions to electricity and magnetism most important; that if he himself (John Hopkinson) had done the work his charges would have been in accordance with the rate just stated.

Dr. Louis Duncan, of Johns Hopkins University, was called for the prosecution, and testified to the high professional standing of Prof. Rowland, and to the amount of work Prof. Rowland had devoted to the report. He said that Prof. Rowland had worked on the average seven hours a day on the report for a period of six months; that the report contained the results of much original investigation and research, and was of very great value to the defendant.

Mr. F. J. Sprague was called by the prosecution to prove what was reasonable compensation, and after stating his connection with electrical engineering, and before answering any question relative to amount of compensation, was examined by the counsel for the defense to test his competency to testify, which resulted in a lively skirmish between the counsel of the two sides, and ended by the court qualifying the witness. The witness stated on direct examination that his usual charge for consulting on work which required no original ideas was 5 per cent. of the cost of the plant; where original investigation or invention was necessary 7 1-2 per cent. to 10 per cent. On cross examination the witness admitted that where such percentage charge was made it was generally arranged beforehand. He also admitted that if a corporation hired ten consulting electrical engineers at this last rate the whole property would be consumed, but added that if any corporation was foolish enough to hire ten such experts they ought to have all their property taken away from them. Witness admitted that if such expert devoted a large part of his time to villifying and condemning a fellow worker he should not charge for such time, but should make a deduction from his bill, but would not admit that it should make any difference whether his work was used or not. Witness testified that he was a member of the corporation of Sprague, Duncan & Hutchinson, but refused to answer how much he got for his work for the North American Company, the Baltimore and Ohio Company, the Rapid Transit Commission or any other client. He also declined to state whether the whole receipts of the whole five members of his firm for one year were not less than $25,000.

Prof. Barker, of the University of Pennsylvania, was then called and began to establish Prof. Rowland's standing. Mr. Choate rose to say that the defense admitted Prof. Rowland's standing, and had never disputed it. His client always wanted the best of everything that could be bought, and that is why they hired Prof. Rowland. Mr. Wise asked if the defense admitted that the plaintiff was the only man who could do the work that was given him, and Mr. Choate replied: "We do not admit that if Prof. Rowland was to die electrical science would come to a standstill." Mr. Wise began to examine the witness as to usual fees of electrical experts, when Mr. Choate questioned Prof. Barker's competence as a witness, and was allowed by the rules to examine him on that point, as in the case of the last witness, before he testified further. Witness stated on this examination that he was interested in keeping up the prices of expert services, that he had worked for the various Edison companies, for the United States Company and for the Fort Wayne Company, all on the percentage basis, and that the per diem compensation for ten years ought to be same as for a single day, but he admitted that there might be a usage reducing the rate as the time is greater. The Judge asked the witness if the magnitude of the undertaking was in itself sufficient novelty to require original investigation, and the witness replied in the affirmative. The Judge then declared the witness qualified. The witness on direct examination said that Prof. Rowland was the only man who could prepare this work and get it into shape for engineers to take hold of. On cross examination he said that had Prof. Rowland died or never existed, the work could not have been done by any one in this country, but he could not mention any new principle, idea, discovery or invention in Prof. Rowland's report, or show any new application of theory to practice, or any novelty beyond the magnitude of the enterprise.

Dr. Jacques, of the American Bell Telephone Company, was then called to prove what was reasonable compensation. He stated that as an officer of the Bell Telephone Company he audited the bills of electrical experts, and in his connection with the Massachusetts Engineering Company he was himself an expert, and charged, like an architect, a percentage. On the examination for competency he said that he had himself been employed to determine the proper size of wire and other matters relating to the direct New York and Chicago telephone line for a considerable time on a per diem compensation, besides his salary. Witness also said that Prof. Cross had been employed from five to seven months on a per diem compensation, and Mr. F. L. Pope a longer time, but admitted that Mr. Pope had part of the time been an expert witness. Mr. Choate objected that two cases did not establish a precedent. The court ruled that it would admit instances of per diem compensation of four or five months' duration. Witness then mentioned the employment of experts by the city of Boston to investigate the deterioration of water pipes, and was qualified by the court. Witness stated on direct examination that Prof. Riker had been paid $100 per diem and other experts $50; that the work for the Cataract Construction Company performed by Prof. Rowland was so extraordinary and that it justified an extraordinary charge. He considered the charge should not be less

than $37,500. On the cross examination Mr. Choate asked the witness if $157,500 would not be more just, to which the witness replied in the negative. Mr. Choate was pleased to hear that there was some charge which the witness considered excessive. The witness further said that he was interested in depressing rather than raising expert charges. He knew of no more per diem payments for services lasting six months, nor five months, four months or three months. An instance of per diem compensation for two months was Prof. Cross at $100, and Prof. Riker at $100 on microphone work was another. Mr. F. L. Pope and Mr. d'Infreville were also mentioned. On direct examination witness stated that Mr. Pope received $50 per diem. Witness was asked if he was not the man who had put the plaintiff up to sue for $30,000. Question objected to, on the ground that what witness had said in that respect was in a letter; if defense would admit letter in evidence plaintiff would admit the point, but otherwise he would admit nothing. Defense would not admit the letter in evidence.

Mr. Joseph H. Choate then addressed the jury. He stated that Prof. Rowland was at the head of his profession and they expected to pay him well, and had paid him well; in fact, more than any one else. At the rates proposed by the plaintiff's witnesses, however, experts would devour any company. Ten would take it all. The business of the defendant was to harness the waters of Niagara and furnish water power for use there. The proposed electric transmission to Buffalo was only 10,000 h. p., or one-tenth of the whole. The general plan was decided before Prof. Rowland was employed. The dynamo was worth at most $50,000. Mr. Wise here interrupted to know if Mr. Choate was opening the case or summing up, and a wrangle ensued, after which Mr. Choate resumed. He said it was an excellent thing to get Prof. Rowland to do this work, as also to secure a practical electrical engineer and a mechanical engineer. Three things were necessary—ideas, electricity, mechanics—but should the defendant company for that reason be compelled to pay three times $37,500? Prof. Rowland receives a salary of $5,000 per annum from the Johns Hopkins University. Four years ago he was employed by defendant for something over two months, for which he was paid $1,000, with which he was apparently perfectly satisfied. Prof. Rowland had characterized Prof. Forbes as puerile, foolish, ignorant, partisan, etc. He had undoubtedly learned a great deal himself in the course of his work. There was nothing new in his report; neither he nor Dr. Barker could name any novel feature. Five hundred dollars per month was more than Prof. Forbes or Dr. Sellers received. Plaintiff was put up by Dr. Jacques to ask $30,000, because $10,000 was too much. Mr. Choate then exhibited a model of the dynamo designed by Prof. Forbes and Dr. Sellers, and said that all its substantial features were different from that in Prof. Rowland's report.

Mr. Rankin, of the Cataract Construction Company, was then called for the defense. He stated that the business of the Cataract Construction Company and its associate, the Niagara Power Company, was the development and renting of water power. Up to the present time only about 3,000 h. p. had been developed, which is in use now on the spot; that the capacity of the tunnel is 100,000 h. p., and that the electric transmission is as yet entirely prospective. The project had been broached in 1889, and Prof. Rowland had reported when first consulted that transmission to Buffalo was impracticable in the then state of the art by either direct or alternating currents. In 1892 Prof. Rowland had changed his opinion on account of the progress in the art. In 1890 the Niagara International Commission was formed. It consisted of Lord Kelvin, Dr. Coleman Sellers, Prof. Mascart and Col. Turrettini, commissioners, and Prof. Unwin, secretary. This commission was formed to consider plans and to award prizes therefor, with power to withhold any or all prizes if they saw fit so to do. They examined twenty-six plans, but used only fourteen. They decided upon the use of a 5,000-h. p. dynamo, or two dynamos of 2,500 h. p. each, if any dynamo were used at all. The efficiency was guaranteed in each case in connection with the plan. The Oerlikon and Brown plans were considered practicable from an engineering point of view, but two purely commercial considerations prevented their acceptance: First, the high tariff; second, the distance of the factory from the power station. The Westinghouse company had guaranteed the performance of the machine and the price was less than $50,000. Witness saw the plans submitted to the international commisssion; they comprised long and short transmissions; the former meant fifteen miles or more and the latter use on the land of the company. Lord Kelvin received £500 for his work on the commission, Prof. Mascart £400, Col. Turrettini £400, and Prof. Unwin £400. Dr. Sellers was at the time on a salary of $12,000 per year from the company. His present salary is $5,000, and Prof. Forbes' salary and expenses amount to about $400 per month. Witness further said that Prof. Norton reported on the development of Niagara, including electric transmission, in November, 1889, charging $250. Dr. Hopkinson, in the spring of 1893, reported on the type of dynamo, number of phases, etc., charging $250, the work occupying perhaps three weeks. Prof. Fleming reported on the same subject, charging £10.

Dr. Sellers was then called by the defense. He said that in 1890 he visited the Rome and Tivoli transmission plant, also the Deptford-London installation at 10,000 volts; that the present apparatus of the defendant was designed entirely by Prof. Forbes and himself, and was entirely different from that in Prof. Rowland's report. Under cross examination the witness stated that Lord Kelvin was employed by offering him £500 in advance, and that he was well satisfied with the price. The commission awarded two second prizes, but no first prize. On redirect examination witness said that there was a consensus of opinion of the commission at that time in favor of continuous current transmission, but that since that time all the members of the commission, with one exception, had been converted to alternating current transmission, which Prof. Forbes had all the time advocated.

Mr. William Stanley, Jr., was then called, and stated that artificial cooling of transformers was not new at the time of Prof. Rowland's report; that James B. Fuller, in 1887, had used it, and that Mr. Swinburne had used a chimney draught for the purpose.

Prof. George Forbes was then called for the defense. He said that he had continuously advocated alternating currents since 1890, and that all the essential features of the present plan, including two-phase transmission and synchronizing motors, were decided upon before he saw Prof. Rowland's report; that although Prof. Rowland might have discovered the importance of the sine curve at the time of his report, it was public property and practically applied. Prof. Forbes refused to answer many questions which he apparently considered as bearing on controversies foreign to the suit, and avoided making reflections on others.

Mr. Choate, in his closing address to the jury, said that the ideas of philosophers and discoverers have never been convertible into large sums of money. Nothing could be more valuable to humanity than the discoveries of such men as Galileo and Newton, but they never sent in any bills, but with the advice of Dr. Jacques, Galileo would have claimed 5 per cent. of the earth and Newton 10 per cent. of the universe. Mr. Wise replied in his speech that had Galileo and Newton done work for millionaire corporations they probably would have sent in bills.

The jury was out about an hour, and brought in a verdict for the plaintiff for $5,500, the unpaid balance of $9,000.

Notice of appeal was given.

# THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE PRINCIPAL FOREIGN ELECTRICAL JOURNALS.

BY CARL HERING.

## ELECTRO-PHYSICS.

*Dielectric Hysteresis.*—Referring to the researches of Mr. Arno (see Digest Jan. 20 and July 15), Mr. Meylan, in "L'Elec.," Dec. 30, states that the author committed an error and that the numerical values given by him are therefore quite wrong, and are not physical constants but simply results of experiments under certain circumstances; the error lies in the assumption of the value of the electric field.

*Dynamical Theory of the Electric and Luminiferous Medium.*—The Lond. "Elec. Rev.," Jan. 5, publishes the first portion of an abstract of a Royal Society paper by Mr. Larmor on this subject; the present portion is devoted almost entirely to phenomena which are neither electrical nor magnetic.

*Sudden Acquisition of Conducting Power.*—The "Phil. Mag.," for January, contains a communication from Prof. Lodge "On the Sudden Acquisition of Conducting Power by a Series of Discrete Metallic Particles," forming a part of the discussion of Prof. Minchin's paper mentioned in the Digest Dec. 23.

*Currents Produced by Heating.*—"La Lum. Elec.," Dec. 30, mentions an article in "Science" by Mr. Stelle, on his researches in the production of electric currents in single metals by the action of heat.

*Rotary Field Apparatus.*—Mr. Blondel's mathematical article is continued at some length in "La Lum. Elec.," Dec. 30, a mathematical theory of non-synchronous rotary field motors being deduced.

*Propagation of Light in Metals.*—Mr. Raveau's article is continued in "La Lum. Elec.," Dec. 30.

*Dissociation.*—"La Lum. Elec.," Dec. 30, contains a note referring to an article by Mr. Wildermann.

## MAGNETISM.

*Magnetic Elongation.*—The "Phil. Mag." for January contains an illustrated paper by Mr. Nagaoka on "Hysteresis Attending the Change of Length by Magnetization in Nickel and Iron"; also a supplementary paper by Prof. Knott on "Magnetic Elongation and Magnetic Twist Cycles."

*Transformation Produced in Iron by a Strain.*—"La Lum. Elec.," Dec. 30, abstracts an article by Mr. Charpy from "Comptes Rendus," in which he shows that a permanent deformation produces a modification which may be considered as an allotropic transformation of the iron.

*Magnetic Shielding.*—Prof. Ruecker's Physical Society paper on "The Magnetic Shielding of Concentric Spherical Shells" is contained apparently in full in the "Phil. Mag." for January.

## UNITS, MEASUREMENTS AND INSTRUMENTS.

*Registering Instruments.*—Dr. Raps, in the "Elek. Zeit.," Jan. 4, gives in detail with the aid of eight illustrations a description of an improved registering instrument, the principle of which is briefly as follows: A drum revolving once in twenty-four hours and enclosed in a box contains a band of sensitized paper; the light from an incandescent lamp passes through a slot on to this drum, producing a sharp line of light parallel to its axis; the pointer of the measuring instrument moves over this slot, its position at every moment is therefore recorded by its shadow on the sensitive paper; vertical wires are stretched in front of the slot and are photographed on the paper in the form of lines; a glass disc with graduations representing the hours revolves between the slot and the drum, thus photographing the time on the sensitive paper; the readings on the paper are therefore entirely independent of the position of the paper, and it is therefore made possible to recover the drum with sensitive paper in a closed box with openings for the hands and without being necessary to see the paper itself.

*Standard Cells.*—Mr. Rimington, in a short article in the Lond. "Elec. Eng.," Jan. 5, states that a Clark standard cell is perfectly unharmed by being circuited through a resistance of 1,000 ohms which opinion he bases on experiments made with two identical cells, one of which was closed through 1,000 ohms for 17 minutes, its internal resistance being about 130 ohms and the current therefore 1.27 milliamperes; the circuit was then broken and the E. M. Fs. compared with that of the other cell, showing that in nine minutes it recovered sufficiently for all practical purposes, the recovery being complete in one hour and 20 minutes.

*Resistance of Compressed Bismuth.*—"La Lum. Elec.," Dec. 30, abstracts an article by Mr. van Aubel, in which he shows, among other things, that the influence of magnetism on bismuth does not depend appreciably on the molecular state of the bismuth, so long as it is pure.

*Shunts.*—The somewhat lengthy correspondence on shunts is continued in the Lond. "Elec. Eng.," Jan. 5, in the form of a lengthy dissertation on the subject, intended more particularly for amateurs.

## DYNAMOS AND MOTORS.

*The Dynamos for Niagara Falls.*—Mr. Weekes, in the Lond. "Elec. Eng.," Jan. 5, in the form of a discussion of Prof. Forbes' paper, gives an illustration of a Brown machine from Kapp's book, page 345, intended to show the great similarity between this and the form designed by Prof. Forbes.

*Irregularities in the Action of Dynamos.*—The article by Mr. Montpelier is continued in "L'Elec.," Dec. 30.

## TRANSFORMERS.

*Transformers.*—In his serial on "Electric Light and Power" in the Lond. "Elec. Eng.," Jan. 5, Mr. Guy discusses transformers.

## ARC AND INCANDESCENT LIGHTS.

*Scientific Study of Arc Lamps.*—A fifth paper of Mr. Kennedy is contained in the Lond. "Elec. Rev.," Jan. 5; in it he discusses lamps with inclined carbons with a lateral motion, and lamps with electromagnetic feeding devices; he gives an illustration of an hydraulic device, the action of which is analogous to that in an arc lamp.

## ELECTRIC RAILWAYS.

*Electric Traction.*—The Lond. "Elec. Rev.," Jan. 5, contains an article by Mr. Epstein, the purpose of which is to investigate the relative merits and costs of the three different systems, overhead, underground conduit and accumulator,

his estimates being based as far as possible on data relating to actual working. The article, of which the first portion only is given, appears to be well worth reading in its entirety, as it consists mostly of tables and figures; from these the following are extracted: The cost of a 90-pound rail he gives as $4,000 per mile of single track, which is the same for all three; for the laying and paving, $25,000 per mile, the same in all three; for the overhead work, $2,400 per mile; for the underground structure for a conduit road, about $7,500 per mile; for feeders he gives a more extended table for a number of different conditions; for cars on trucks for forty passengers, $1,150 per car; for motors and gearing, $900, the same for all three; for accumulators and trays, allowing 2 1-2 sets of accumulators of 72 cells each for each car, for four to six hours' running with one charge, the cost of the batteries for a forty-passenger car will be $1,800; for trays and connections, $90; for elevators for handling the accumulators, $250 to $600 per car; for buildings and car sheds, $1,000 to $2,000 per car, for all three systems; for boilers and engines at $40 per indicated horse power, $160 per ton propelled, assuming four indicated horse power of steam plant for every ton weight propelled, which includes the reserve plant; this is for the overhead and underground systems; for the accumulator system, $90 for the steam plant per ton weight propelled, based on 2.2 indicated h. p. of steam plant for every ton weight propelled; for the electrical plant at the station for the overhead and underground systems, 385 for every ton weight propelled, based on 2.4 kilowatts per ton propelled; for the accumulator system, $52, based on 1.5 kilowatts per ton weight propelled; from a table of efficiencies the average total efficiency for the overhead and underground systems is 27 per cent., while that for the accumulator system is 33 per cent. Two large tables are given containing the detailed expenses of the cost of construction and equipment of a double-track line six miles long with cars for forty passengers, average speed, including stoppages, six miles an hour, and weight complete, with passengers, eight tons; for the overhead system, using insulated wire for feeders, the cost per car per mile of double track for five-minute headway and twenty-four cars, is about $91,450, while for the underground system it is about $102,000, and for the accumulator system for a weight of ten tons per car it is $79,765; similar figures are given for twelve cars and ten minutes' headway and for forty-eight cars and two and one-half minutes' headway. The above figures are at the rate of $5 per pound sterling, which is slightly higher than the actual exchange.

*High Speed Railways.*—In a short article by Mr. Lea in the Lond. "Elec. Eng.," Jan. 5, he bases a calculation on the data given by Dr. Hopkinson, from which he finds that the air resistance per square foot of area is nearly 33 pounds at a speed of 200 miles per hour; this figure is extremely high when compared with 15 pounds, which Mr. Crosby in his experiments found to be 50 per cent too high. He thinks that such speeds will be attained only by a complete change in the type of roadway adopted, and he thinks that the Lartigue single-rail system may be a forerunner of a permanent roadway suitable to high speeds, but he doubts whether any ordinary girder work on a foundation which is more or less shallow would serve the purpose.

*Electric Equipment of Steam Roads.*—According to the "Elek. Zeit.," Jan. 4, the steam railroad from Arad to Csanader is to be equipped for a portion of its route with a system of electric traction; the railroad cars will be equipped with electric motors and will receive current from an overhead line; trains can thereby be propelled after the locomotive has been uncoupled; if this is a success the whole line will be changed into an electric road.

*Gas Motors for Street Railways.*—According to the "Elek. Echo," Dec. 30, a street car with gas motors was recently started in Dresden; it contains two motors of 8 h. p. each, weighing 1.9 tons each; the car without passengers weighs 8.5 tons; 1.3 cubic metre of gas is carried at 6 atmospheres in 10 receptacles, but it does not state for how long a trip this will suffice.

*Liverpool Overhead Railway.*—This, the first electric overhead railway, although started as recently as March of last year, is to be extended; although the contractors were under obligations to work the line for two years at 8 cents per train mile, the working has been so satisfactory that the railway company has decided to take over the line from the beginning of this year.

*Electric Railways in the British Kingdom.*—The Lond. "Elec.," Jan. 5, gives a list of the railways in operation and projected, representing a total of 44 miles, of which 23 3-4 miles are operated by the third-rail system, three by accumulators, two by conduit and 15 1-4 by the overhead (trolley?) system; the projected roads amount to 37 miles.

*Rules and Regulations.*—The "Elek. Echo," Dec. 30, publishes the rules for electric railways in the city of Leipsic.

### CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

*Central Stations in Germany.*—In an article in the "Elek. Zeit.," Jan. 4, comparative data are given for six large stations in Germany, the deductions from which are quite interesting; the data are all given in the form of tables, which cannot be reproduced here, but they are well worth the attention of those interested in central station work. Among some of the features are the following: In general the financial returns, even during the first year of operation, were satisfactory; an amortization of 4 per cent. on the total capital invested is found to be sufficient, among which is an item of 6 per cent. on the accumulators; the increase of the income over the expenses in per cent. of the cost of installation is about 7 per cent. for the lowest of these six stations (Cologne) to about 18 per cent for the best (Hamburg); a detailed table is given showing the operating costs, the ratio of the generated to the consumed energy, which varies from 70 to 97 per cent., and various other items, general averages of which cannot well be given; the cost of generating per kilowatt hour consumed varies between about 4.7 cents to 7.0 cents. The average watt efficiency of the accumulators varies from 71 to 79.5 per cent. and the loss in the accumulators in per cent. of the total current leaving the station varied from 11 to 14 per cent. In these stations from 35 to 62 per cent. of the total energy came from the accumulators; the maximum current in per cent. of installed lamps varied from about 36 to 68 per cent. and the average time of burning of installed lamps varied from about one to two hours per day.

*Central Stations in the British Kingdom.*—The Lond. "Elec.," Jan. 5, publishes as a supplement a table of the central stations in operation and in progress in London and in the provinces, giving, in tabulated form, the most important data for each; the table is interesting, especially as there are very few blanks; general deductions of any value can hardly be made.

See also paragraph on "Review of the Past Year," under "Miscellaneous."

*Three-Phase Installation at Wangen, Wurtemburg.*—The "Rev. de L'Electricite," Dec. 31, describes briefly this installation, which was started in April of last year. There are two stations about one mile apart, which feed in common into the same mains; the principle station has a 200-h. p. dynamo driven by a turbine; by means of transformers the voltage is raised from 3,000 to 5,200; the second station is supplementary and is used only when the first is insufficient; it is located in a factory, the power for which is ready whenever it is required; the second dynamo is a 100-h. p.

machine; the two are connected in parallel by the usual method; in the city there are three secondary transformer stations of 20 kilowatts each; the motors are run from the three wires, but for the lighting the system is divided into three separate currents, each of which leads to different districts, the return being by means of a common neutral wire, thus making four wires in all, and to this modification the successful application to both lighting and power is attributed; motors up to 50 h. p. are in use; an increase of the station is already contemplated.

*Multiphase System at Budapest.*—This installation, although it has been in operation for only two months, is to be extended; the frequency used is 25 and the voltage 2,000, the multiphase currents being transformed into continuous currents for distribution.

*Single-Phase vs. Two-Phase System.*—Mr. Kennedy, in the Lond. "Elec. Rev.," Jan. 5, criticises unfavorably the system of Messrs. Reis and Scott recently described in The Electrical World, in which he says that "the extravagant claims made by the inventors cannot be admitted for a moment in the absence of evidence of their having accomplished the feats described"; he states that what they have written does not convey "the remotest idea as to what it is they have really discovered."

*Copenhagen.*—In the "Elek. Zeit.," Jan. 4, Mr. Uppenborn gives a well illustrated description of this station, installed by the firm of Siemens & Halske; the continuous current, three-wire system is used in connection with a large accumulator battery.

*Motive Power and Gearing.*—Mr. Carter's serial is continued in the Lond. "Elec.," Jan. 5; he discusses the storage of energy and in general the study of motive power and gearing.

*Fuel Economy.*—The Lond. "Elec. Rev.," Jan. 5, contains an article on this subject.

### WIRES, WIRING AND CONDUITS.

*Cost of High Tension Lines.*—"La Lum. Elec.," Dec 30, contains an article by Mr. Bocherot, in which he discusses the various conditions which enter into the problem. He expresses surprise that the statement should have been made (see Digest Oct. 14) that if one accepts as a limit 10,000 volts, for instance, for continuous currents, the effective limit for alternating currents ought not to exceed 7,000 volts, and that therefore an alternating current line costs double that of a continuous current line; he states that experience has shown this reasoning to be erroneous; alternating currents act beneficially on the insulation when compared with the destructive electrolytic action of continuous currents; on account of the lag in phase between the voltage and the current the cost of a line is greater for alternating currents than for continuous currents, but this is of small importance considering the relative ease with which high voltages may be generated with alternating currents. He then discusses the conditions for the minimum cost and gives a proof of Lord Kelvin's theorem; in discussing it, he states that the copper and not the poles, subways, etc., should be considered as variable, and for the price of a kilowatt hour one ought not to take that for the ordinary distribution but that for generating so many additional units; in the case of water power the price of the energy lost should be replaced by the interest and amortization on the capital invested in the increased size of the machines corresponding to the lost power; whether the power is furnished by steam or water the conditions for minimum cost are independent of the length of the line; for overhead lines of bare wire the application of Lord Kelvin's law is quite simple, but not so when the lines are underground; in the latter case there is a third factor, namely, the interest on the capital in the insulation, depending on the voltage and on the cross-section, and which can be considered as proportional to the voltage and to the diameter, that is, to the square root of the section; if the voltage is fixed in advance, this third factor may be considered as proportional to the square root of the section; he discusses the case of the voltage not being fixed and endeavors to find the most economical value to give to it, for if the expense of the insulation is considered, the highest voltage is not always the most economical; if the loss of energy in the line is considered constant, the section or the price of the copper will be inversely proportional to the square of the voltage; the only expense will then be the sum of three terms, two of which, the loss and the insulation, are constant and the third is inversely proportional to the square of the voltage; the voltage should therefore be as high as possible; if the weight of the copper, that is, the interest on the capital, is assumed constant, the price of the insulation will be proportional to the voltage and the annual expense will be the sum of three terms, of which two are constant and the third proportional to the voltage; in this case it is best to diminish the voltage as much as possible; in the third case he shows how the best conditions may be arrived at by a few trial calculations. He then considers the subject of the capacity of the line and the advantages of using condensers.

*Resistances With Alternating Currents, Errata.*—In the table published in the Digest last week under this heading, the commas in the values for K should be periods, thus making the values of this constant begin with unity.

### TELEGRAPHY, TELEPHONY AND SIGNALS.

*Signalling Between Trains in Motion.*—The Lond. "Elec. Eng.," Jan. 5, describes briefly the trials made in Germany in October with the Perls system, which resulted very favorably; a battery is carried on each locomotive and is connected by sliding contacts, with conductors laid parallel to the rails, these conductors being divided into block systems in such a way that if two trains are on the same block both engineers will be warned of each other's presence by the ringing of a bell on each locomotive, while at the same time they are brought into telephonic communication with each other.

*Interchangeable Telephone System.*—The Lond. "Elec.," Jan. 5, publishes an illustrated description of the Sloper system, especially adapted for factories, institutions, dwellings, etc., as no central station and no services of an attendant are required; the system is so arranged that it is impossible to leave the instrument in a condition which interferes with the talking of other stations or in a condition in which it cannot be rung up.

*A New Telephone.*—"L'Elec.," Dec. 30, quotes from the journal "Le Nord," stating that a new telephone invented by Gwozdeff is to be installed between Odessa and Nicolaieff; no description is given, but it is stated that the telephone can be used for transmissions to very great distances through a single telegraphic wire without interfering with the regular telegraphic services; messages may be transmitted simultaneously in four different directions.

*Improved Mouthpiece.*—The "Elec. Tech.," Dec. 15, states that in Germany a mouthpiece is being introduced for public telephones, the object of which is to avoid the spread of diseases carried by the condensed moisture of the breath; a pad of a large number of discs of paper, with a hole in the middle, is inserted in the mouthpiece and after or before every conversation the upper disc of paper is torn off.

### ELECTRO-CHEMISTRY.

*Electrolysis with Alternating Currents.*—The Lond. "Elec Rev.," Jan. 5, calls attention to a paper by Mr. Malagoli in the "Jour. de Physique," August, 1893, in which he states "that the phenomena of electrolysis produced by alternat-

ing currents must be considered as a succession of elementary electrolyses when there are alternations of current; hence it becomes necessary in studying the elementary phenomenon by applying to a single alternation the well-known laws of electrolysis, and then integrating with respect to the number of alternations which the current makes in a given time." At the end of his mathematical discussion he deduces the following general conclusions: "The necessary and sufficient condition under which electrolysis by alternating currents is possible is that the quantity of electricity passing through the voltameter during a single alternation of current must be greater than twice that which is necessary to produce in the voltameter the maximum polarization. Electrolytic production ceases when these two quantities are of equal value and the amount of electrolyte decomposed is proportional to the difference between these two values."

*Electric Concentration of Sulphuric Acid.*---Mr. Blount, in the Lond. "Elec.," Jan. 5, discusses some recent theoretical calculations, and claims that direct experiment is the only means for determining the value of such a process; hot concentrated sulphuric acid is not a very familiar electrolyte and but few can foretell its behavior with any pretensions to accuracy; experiments have been carried out which, he claims, show that the electric process is not sufficiently economical to supersede the other; a current of 14 amperes and 7 volts was sent through a platinum wire in a beaker of sulphuric acid at 60 degrees B., raising its temperature to 190 degrees and causing it to lose about 11 per cent. in weight in 2 1-2 hours; the comparatively large loss was due to electrolysis, and sulphur was separated; in order to overcome the effects of electrolysis the acid and the wire were placed in a tube, and it was found that only when the tube was small tolerable results were obtained, but even then the success was not sufficient to warrant its continuance with direct currents, but with alternating currents electrolysis nearly disappeared; thus, with 14 amperes and 7 volts, it was concentrated to 65.8 degrees B., with a loss of weight of less than 20 per cent.; the energy amounted to 1.49 kilowatt hours for 1 kilogram of concentrated acid, which represents an efficiency of 25 per cent. and does not compare favorably with the usual method. (The efficiency, however, seems to be of less importance than the outlay for the large platinum discs required in the usual process.)

*Primary Batteries.*—Dr. Battandier in "Cosmos," Dec. 23, describes several new batteries; one by Mr. Rosati contains a negative plate of lead, to which 5 per cent. of tin is added to make it oxidizable in sulphuric acid, the positive electrode is made of retort carbon and the liquid is a mixture of equal parts of sulphuric acid and nitric acid, with water in proportion depending upon the desired effects; the lead is dissolved, forming a heavy precipitate, which falls to the bottom, thus keeping the lead surface always clean; the cost of a kilowatt-hour is given at $1.20, but by selling the bi-products this is reduced to 40 cents, if the battery is used on a large scale. In the battery of Kousmine carbon plates are surrounded by a 7 per cent. solution of chromate of potassium, while the zinc is in sulphuric acid, the liquids being separated by their specific gravity. He also mentions a process for reversing a Daniell cell; after a cell is exhausted the liquids are poured away, sulphuric acid is poured in the porous cup containing the copper, while a concentrated solution of sulphate of zinc is poured in the portion containing the zinc, the cell is then short circuited, in which case it is claimed that the current is reversed, the copper being dissolved into copper sulphate and the zinc deposited from the solution on to the electrode, after which the cell is again ready for use; he does not vouch for the correctness of this statement.

*Purification of Sewage.*---Mr. Webster, in a communication to the Lond. "Elec. Rev.," Jan. 5, claims that the Hermite process at present used is covered by his (Webster's) patent of 1887, from which he quotes at some length. He claims that the hypochlorous acid formed, although an admirable disinfectant, acts injuriously on bricks, cement, metals, etc.; instead of electrolyzing sea water and mixing it with the sewage he advocates treating the sewage directly, in which case the chlorine compounds are much more active than chlorine in solution; the sewage need only have its alkalinity neutralized; he describes at length his process, in which the sewage is brought into contact with large positive and negative electrodes of iron, which produces an effluent not liable to secondary decomposition and innocuous to the rivers into which it flows.

*Electric Tanning.*---A short description of the projected installation at Orbe, Switzerland, using the Groth system, is given in the Lond. "Elec. Eng.," Jan. 5; this installation when finished is estimated to turn out 1,000 hides per week; the power is obtained from a waterfall nearly two miles distant. The results of a test made by Prof. Unwin are given, in which he states that the leather thus tanned is rather above the average strength of good leather belting.

### MISCELLANEOUS.

*Electric Ignition of Benzine in Laundries.*—Referring to the danger of the ignition of benzine by the discharge of the electicity generated in rinsing clothing in baths of benzine, as described in the Digest last week, Dr. Goehring states in the "Elek. Rundschau," No. 6, that by adding to the benzine 2 per cent. of a soap which is soluble in benzine the danger is completely avoided, as it is then no longer possible to detect even the slightest electrification by means of an electroscope; its properties as a cleansing material are not only not destroyed thereby, but even increased.

*Review of the Past Year.*---The Lond. "Elec." Jan. 5, gives a general review of the electrical industry during the past year, especially in Great Britain; it states that there has been a considerable and sound extension in the business of supplying electricity; no new central stations have been opened in London; the twelve companies and one vestry in London have about 700,000 lamps of 8 c. p. connected, as compared with 500,000 a year ago; prices have gone down and dividends are said to go up; it is followed by a diagram showing by means of lines the statistics for London and the provinces for the year 1889.

The Lond. "Elec. Rev.," Jan. 5, also reviews the past year in an editorial. It states that "some persons affirm that the year has been fairly prosperous, but a dismal cry comes from the great majority; * * it must be confessed that the record at best is a sombre one." It states that there has been a considerable increase in central stations and that most of them are due to municipal enterprise; a year ago the number of alternating and direct current systems was about equal, but now the proportion is 45 to 34, and among the more recent ones 21 to 9; house transformer systems are being abandoned in favor of central transformer chambers.

The editorial on the same subject in the Lond. "Elec. Eng.," Jan. 5, includes quite a large number of letters from different English manufacturers, enumerating the work accomplished by them during the past year.

*Summary of Electrical Events for 1893.*—The Lond. "Elec.," Jan. 5, publishes a good chronological summary, not only for Great Britain, but for the electrical world in general.

*An Electric Balloon.*---The "Rev. de l'Electricite," Dec. 31, states that at the Antwerp exhibition of 1894 there will be a balloon driven electrically, which will make regular trips from the centre of the city to the exhibition; it will be about 260 feet long and 52 feet in diameter, carrying from

20 to 25 passengers, and will be operated by 125 h. p.; it will receive its power through a flexible cable connected to a sort of trolley, which travels on fixed overhead wires, the current being generated by gas engines; the amount of power per unit of weight of the balloon is by this means increased sevenfold over that if the source of power were contained on the balloon itself; in the latter case it was found that at least 110 pounds were required per effective horse power, and even then it would not be powerful enough to resist a strong wind. (The idea of supplying power to a balloon from fixed overhead wires and a travelling contact was suggested several years ago by Dr. Bonwill, of Philadelphia, in a paper read at the Franklin Institute.)

*Electric Shot Firing in Mines.*—The Lond. "Elec.," Jan. 5, publishes an abstract of a paper by Mr. Houghton, which, however, is intended more for mining than for electrical engineers. He states that electric firing has made very rapid strides and is considered by the government inspectors to be the only safe method by which the safety explosives now in use can be fired. In the history of this subject he says that "Mr. Franklin in America" suggested the possibility of the elect ic ignition of gunpowder in 1751. He explains in detail the different systems, including high and low tension electric exploders and fuses, the series and the parallel circuit system.

*Acidity Indicator.*—According the "Elek. Tech.," Dec. 15, an instrument was exhibited in Paris for indicating the degree of acidity during the process of fermentation; it consists of a zinc and a copper plate bolted together so as to remain a fixed distance apart, which are inserted in the liquid and short circuited from a valvanometer, the reading of which will indicate the degree of acidity, and may be used to measure it.

*Ignition of Benzine in Chemical Laundries.*—Referring to the phenomenon mentioned in the Digest Jan. 13-20, Dr. Richter, in the "Elek. Echo," Dec. 30, states that by the addition of one-hundredth of one per cent. of a liquid, the composition of which is kept a secret, the generation of electric discharges and the consequent ignition of the benzine ceases completely.

*Cranes.*—The Lond. "Elec. Eng.," Jan. 5, contains the first part of an article on cranes and hoisting apparatus in general, which is to be followed by one on electrical cranes.

*Electric Machine for Voting.*—"La Lum. Elec.," Dec. 30, abstracts briefly a description from the "Rev. Universelle" of the Moreau machine.

*Expenses of an Electrical Engineering Business.*—The Lond. "Elec. Eng.," Jan. 5, contains an article by Mr. Sydney F. Walker under this heading, the object of which is to deter those engaged in this business from the stupid practice of cutting prices.

*Controlling Hemorrhages by Electricity.*—The Lond. "Elec. Rev.," Dec. 29, abstracts an article by Dr. Goelet, of New York, on this subject.

*Electricity in Medicine.*—The "Elek. Echo," Dec. 23, reprints a paper by Dr. Bloebaum.

## A Peculiar Case of an Explosion.

At a further inquiry into the recent explosion on board the "Resolution" at Devonport the primary cause of the accident was ascertained. Part of the mechanism of the evaporator, says the London "Electrician," consists, it seems, of a quantity of zinc slabs and copper pipes; the salt water to be distilled caused electro-chemical action to take place, and it was due to the accumulation of hydrogen and oxygen thus liberated that the explosion occurred. The evaporator is fitted with a safety valve, which, if opened by hand, would have allowed the hydrogen to escape.

## What Is Said of the New Form.

I want to say that the paper is an undoubted improvement.

Knoxville, Tenn. Prof. C. A. PERKINS.

The new size of The Electrical World is a decided improvement and is gotten up in tip-top shape.

Montpelier, Vt. FRED H. PERRY,
L. P. & D. Transmitter Co.

A great improvement. I think you have made a very great improvement in reducing the size of The Electrical World. I do, and always have, considered it the best electrical paper published.

Franklinville, N. Y. B. W. DOUGLAS.

A new and more convenient form. The paper now can be handled with ease and pleasure, and read with exceeding profit to the reader. It is the ablest conducted electrical journal published in this country, and its well-filled advertising pages attest that its patrons fully recognize the fact.

—Boston Journal of Commerce.

The most important and influential electrical journal, The Electrical World, No. 1 of Volume XXIII., comes in a revised form. The size of the pages has been reduced, allowing the publication to be conveniently carried in the pocket. The letter press is in new and modern type, and the paper is of fine quality. The number contains 40 pages of reading matter, and combines all the esssentials of a technical newspaper, with many of the elements that go to make up the highest class magazine.

—The Jewelers' Circular.

A nice-fitting garment. The Electrical World made its appearance last week in a new form, being very neatly and completely presented in 9 3-4 x 13 size. We congratulate the W. J. Johnston Company on the improvement. Our readers will remember a larger paper. The World was rather clumsy to handle, but in its present form it can be easily carried and more practically bound. It contains the same, if not a larger amount, of useful information and data, while its facilities for advertisement are greatly improved and more to the point. The Electrical World has our best wishes for 1894.

—National View, Washington, D. C.

## Moonlight Tables for February, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of February under his modified form of moonlight schedule.

TABLE NO. 1.
Standard Moonlight.
Philadelphia System.

| Date. | Light. | Date. | Exting. |
|---|---|---|---|
| 1 | 5.50 P. M. | 2 | 6.10 A. M. |
| 2 | 5.50 " | 3 | 6.10 " |
| 3 | 5.50 " | 4 | 6.10 " |
| 4 | 5.50 " | 5 | 6.10 " |
| 5 | 5.50 " | 6 | 6.10 " |
| 6 | 5.50 " | 7 | 6.00 " |
| 7 | 5.50 " | 8 | 6.00 " |
| 8 | 6.00 " | 9 | 6.00 " |
| 9 | 6.00 " | 10 | 6.00 " |
| 10 | 9.40 " | 11 | 6.00 " |
| 11 | 10.50 " | 12 | 6.00 " |
| 12 | 12 M. | 13 | 6.00 " |
| 13 | | | |
| 14 | 1.10 A. M. | 14 | 6.00 A. M. |
| 15 | 2.20 " | 15 | 5.50 " |
| 16 | 3.30 " | 16 | 5.50 " |
| 17 | 4.20 " | 17 | 5.50 " |
| 18 | No Light. | 18 | No Light. |
| 19 | " | 19 | " |
| 20 | 6.10 P. M. | 20 | 7.40 P. M. |
| 21 | 6.10 " | 21 | 8.50 " |
| 22 | 6.10 " | 22 | 9.50 " |
| 23 | 6.10 " | 23 | 11.00 " |
| 24 | 6.10 " | 25 | 12.10 A. M. |
| 25 | 6.10 " | 26 | 1.10 " |
| 26 | 6.20 " | 27 | 2.20 " |
| 27 | 6.20 " | 28 | 3.20 " |
| 28 | 6.20 " | 1 | 4.10 " |

Total hours, 196.

TABEL NO. 2.
Frund's New Moonlight System.

| Date. | Light. | Date. | Exting. |
|---|---|---|---|
| 1 | 5.50 P. M. | 2 | 6.10 A.M. |
| 2 | 5.50 " | 3 | 6.10 " |
| 3 | 5.50 " | 4 | 6.10 " |
| 4 | 5.50 " | 5 | 6.10 " |
| 5 | 5.50 " | 6 | 6.10 " |
| 6 | 5.50 " | 7 | 6.00 " |
| 7 | 5.50 " | 8 | 6.00 " |
| 8 | 6.00 " | 9 | 6.00 " |
| 9 | 6.00 " | 10 | 6.00 " |
| 10 | 6.00 " | 11 | 6.00 " |
| 11 | 6.00 " | 12 | 6.00 " |
| 12 | 6.00 " | 13 | 6.00 " |
| 13 | 6.00 " | 13 | 12 M. |
| 14 | 1.10 A. M. | 14 | 6.00 A. M. |
| 14 | 6.00 P. M. | 14 | 12 M. |
| 15 | 2.20 A. M. | 15 | 5.50 A. M |
| 15 | 6.00 P. M. | 15 | 12 M. |
| 16 | 6.00 " | 16 | 12 " |
| 17 | 6.10 " | 17 | 12 " |
| 18 | 6.10 " | 18 | 12 " |
| 19 | 6.10 " | 19 | 12 " |
| 20 | 6.10 " | 20 | 12 " |
| 21 | 6.10 " | 21 | 12 " |
| 22 | 6.10 " | 22 | 12 " |
| 23 | 6.10 " | 23 | 12 " |
| 24 | 6.10 " | 25 | 12.10 A. M. |
| 25 | 6.10 " | 26 | 1.10 " |
| 26 | 6.20 " | 27 | 2.20 " |
| 27 | 6.20 " | 28 | 3.20 " |
| 28 | 6.20 " | 1 | 4 10 " |

Total hours, 246.20.

## Regulation of Arc Currents.

BY DANIEL HIGHAM.

An electric light possesses the seemingly curious property that the E. M. F. required to sustain it falls with increase of current and rises with decrease of current, for which reason it is an impossibility to supply an arc of given and fixed length under constant potential, since it would either take an infinitely great amount of current or extinguish itself entirely. This is the unstable condition of the electric arc.

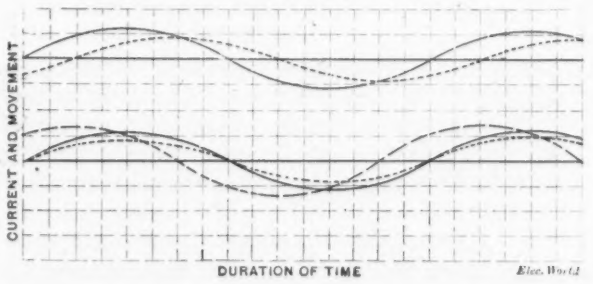
Theoretically, the E. M. F. of an arc could be made to rise with increase of current and fall with decrease of current by lengthening and shortening the arc by a magnet mechanism; but such an action has not been practically carried out, because it has always been behind time in its movement, and a hammering or pumping condition of instability has, in consequence, always resulted.

Instability is overcome in multiple arc lighting by inserting a resistance in each arc branch in order that an increase of current will require a slight increase of E. M. F., and a decrease of current a slight decrease of E. M. F. at the terminals of the branch E. M. F. About 25 per cent. of the watts taken by a lamp are used in this resistance to overcome the unstable condition of the arc, and about 35 per cent. to overcome the hammering, or pumping, condition of instability in the type of lamp in which the arc is lengthened and shortened by variations of current, for which reason the type of lamp now adopted for multiple arc lighting is one in which the magnet mechanism operates simply to feed the carbons.

In series arc lighting stability is obtained by designing the dynamo to work down on the dip of the characteristic, where the E. M. F. will fall with increase of current and rise with decrease of current, to meet the requirements of the arc, but this is obtained at a sacrifice of efficiency and at an increased cost of the dynamo.

The writer, however, assures stability of current in the multiple system without the resistance in the branch by making the current which controls the lamp magnet mechanism (so far as pertains to lengthening and shortening the arc) advance in phase ahead of the current flowing through the arc, and in the series system by making the current which controls the regulator of the dynamo, the mechanism of the lamps, or both, advance in phase ahead of the current in the main or working circuit.

Fig. 1 will serve to illustrate the lag, or loss, of time in the movement of the lamp magnet mechanism of the type

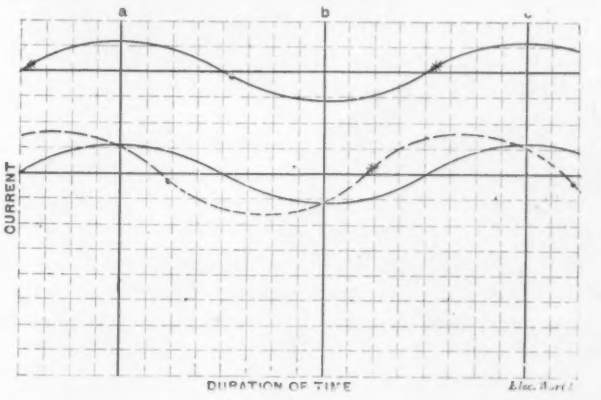



FIGS. 1 AND 2.—REGULATION OF ARC CURRENTS.

of lamp in which the arc is lengthened and shortened by variations of current. The full curve represents an abnormal wave variation of current flowing through the arc and operating (by means of the series coils in the lamp) the lamp magnet mechanism; the dotted line represents the movement of the lamp magnet mechanism, and the straight, or horizontal, line the mean, or normal, intensity of the current and position of the lamp magnet mechanism—the abscissae denoting time and the ordinates the intensity of current and the movement of the lamp magnet mechanism. From this diagram it will be seen that the length of the arc, if controlled by the movement of the lamp magnet mechanism, would not be lengthened and shortened with the rise and fall of current flowing in the former, and a hammering, or pumping, condition of instability would be the result, in the absence of the resistance in multiple arc lighting and of the low efficiency design of dynamo in series arc lighting.

Fig. 2 illustrates the writer's method of operating lamp magnet mechanism in order to lengthen and shorten the arc with the rise and fall of current flowing through the same. The dash line represents a wave variation of an independent, or branch, current, made to differ in phase from the wave variations of current flowing through the arc, and adapted to operate the lamp magnet mechanism. From this diagram it will be seen and understood that the independent, or branch, current would operate the lamp magnet mechanism (allowing for the same amount of lag shown in Fig. 1) in phase with the wave variations of current flowing through the arc, so that stability would be obtained within a small variation of current, according to the sensitiveness of the lamp magnet mechanism employed, and without the need of the resistance or the necessarily inefficient design of dynamo mentioned above.

Fig. 3 will serve to illustrate the loss of time in the per-




FIGS. 3 AND 4.—REGULATION OF ARC CURRENTS.

formance of arc circuit regulators, such as now used in connection with series arc lighting. The full curve line represents an abnormal wave variation of current in the main, or working, circuit, the straight line the mean, or normal, intensity of current, the star (*) the point of time in the wave variation of current, where the regulating mechanism moves to check the rise of current and the period (.) the point where the regulating mechanism moves to check the fall of current; time being denoted by the abscissae and the intensity of current by the ordinates. From this diagram it will be seen that the time from ordinate *a* to ordinate *b* when the current is falling will be more than half spent or lost before the regulating mechanism moves to check the fall of current, and that the time from ordinate *b* to ordinate *c* when the current is rising will be more than half spent or lost before the regulating mechanism moves to check the rise of current, so that hammering, or pumping, condition of instability (adding to that defect in the lamps) would be the result, in the absence of the low efficiency design of dynamo referred to.

Fig. 4 illustrates the writer's method of operating arc circuit regulators in order to make this loss of time less than half the amount spent during the rise and fall of current. The broken line represents a wave variation of an independent, or branch, current, made to differ in phase from wave variations of current in the main, or working, circuit, and adapted to operate the regulating mechanism of the dynamo. From this diagram it will be seen that only a small portion of the time from ordinate *a* to ordinate *b* when the circuit is falling will be lost before the regulating mechan-

ism moves to check the fall of current in the main, or working, circuit, and that only a small portion of the time from ordinate *b* to ordinate *c* when the current is rising will be lost before the regulating mechanism moves to check the rise of current in the main, or working, circuit; as a consequence stability would be thus attained within a small wave variation of current, according to the sensitiveness of the regulating mechanism employed, and without the need of any, or very little, of the properties of stability now given to dynamos used in series arc lighting.

This method of operating or regulating mechanism by an independent, or branch, current advanced in phase ahead of the current wave variations in the main or working circuit is readily accomplished by connecting a coil of high self-induction in parallel with the coil or coils which operate the regulating mechanism—that is, in connection with lamp magnet mechanism—by connecting a coil of high self-induction in parallel with the series acting coils of the lamp, or lamps, and, in connection with dynamo regulating mechanism, by connecting a coil of high self-induction in parallel with the coil or coils which affect the movement of the dynamo regulator. By this means every wave variation of current in the high self-induction branch would be made to lag in phase, and consequently every wave variation of current in the branch operating the regulating mechanism would be made to advance ahead in phase—in the series acting coils of the lamps or the coils of the dynamo regulator, as the case might be.

The resistance of an induction coil to produce the necessary difference in phase between the current operating the regulating mechanism and the current in the main, or working circuit, has been found by the writer in the case of the dynamo regulator to be about an ohm for a ten ampere current in the main circuit, and in connection with lamp magnet mechanism for multiple work about one-third of an ohm.

### The Brown Telephone.

A telephone will be placed upon the market by the Brown Telephone and Telegraph Company, Manhattan Building, Chicago, upon the expiration of the Bell patent on Jan. 30, for which many claims of superiority are made.

The Brown transmitter will, it is claimed by the manufacturers, speak distinctly over a distance of 200 miles or more with a metallic circuit, half that distance with a ground return and 1,000 miles with a special transmitter. Spluttering noises and vexatious confusion of sounds are obviated and the annunciator is surprisingly clear.

THE BROWN TELEPHONE.

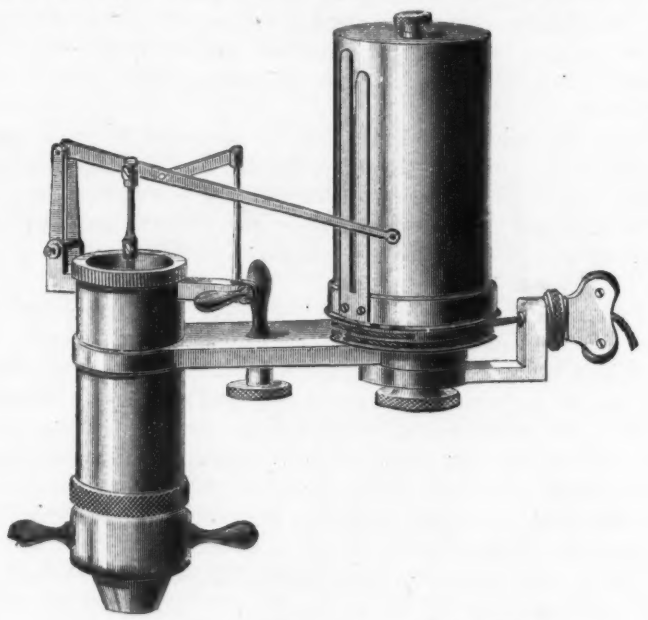
Owing to the absence of any battery the telephone needs no attention, and is satisfactory in all states of weather, and if accidently put out of order it can be easily adjusted by any one.

The Brown telephone is a magnetophone and is sharply differentiated, it is claimed, from all other telephones of its type by the employment of repulsive magnetism. Without the incorporation of this basic principle, the patentee claims that no magnetophone can be made of any commercial value, but are limited to a mile or a little better in their range, and even for such short distance they transmit the voice in a most unsatisfactory and fragmentary way. It is also claimed that for want of this basic principle the Bell Telephone Company is compelled to employ a battery, and that a battery telephone has never yet given full satisfaction.

The manufacturers state that with the aid of expert electricians in their employ they have, at the expense of much time and money, invented their own call dynamo, switch and magneto bell, and have constructed them upon lines so distinct from any employed by others that there can be no question of infringement against the Bell patents.

### A New Indicator.

A new Thompson improved indicator recently brought out by Messrs. Robertson & Thompson, 57 Cortlandt street, New York, is shown in the cut below. It is the standard size, with a piston one-half an inch in area, and exhibits in every detail workmanship of the highest class. The parallel motion is the Thompson improved, designed so that the movement of the pencil is proportional to that of the piston at all points of the stroke. The drum is very light, with cone bearings to take up wear. The double guide pulley can be swiveled so that the cord may lead in any direction.

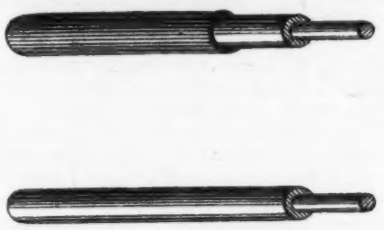


THOMPSON IMPROVED INDICATOR.

### Bimetallic Wires for Telephonic Transmission.

A patent has been recently issued to Mr. W. H. Eckert, 80 Broadway, New York, for an improvement in telephonic transmission, and, generally, in the distribution or transmission of rapidly alternating currents, whose claims are startling in their character. Mr. Eckert is so well and honorably known in the electrical circles, however, where he has occupied positions of the greatest prominence, that claims made by him are entitled to respectful consideration, particularly as they relate to a branch of electricity in regard to which, with our present knowledge, it would be hazardous to dispute the improbability of any assertion from a competent source.

According to the patent specifications the invention for the most part consists in the discovery that telephonic transmission, or rapidly alternating currents in general, may be more perfectly effected upon a bimetallic conductor, such as steel and copper in substantially equal parts, than upon a conductor of one material, such as copper; and with the advantage that such transmission may be effected upon a circuit consisting of a single composite wire and an earth return as perfectly as though two copper wires, each of equal conductivity, were arranged in a closed metallic circuit. In other words, it is found that a single bimetallic conductor joining two distant points is a more perfect medium for tle-



BIMETALLIC WIRES FOR TELEPHONIC TRANSMISSION.

phonic transmission and for conveying generally rapidly alternating currents than are two copper conductors, each of a resistance equal to that of the bimetallic wire; and that from this fact the two conductors necessary to form a single metallic circuit may be replaced by a single wire costing little, if any, more than one-half of a copper metallic circuit. It has also been discovered that less insulation is needed to protect a bimetallic wire than is necessary for copper or other single-substance conductors, in the transmission of rapidly alternating currents, and that from this fact not only the expense of constructing cables, whether aerial, underground or submarine, may be greatly reduced, but more wires may be placed within a cable than could be done if the usual thickness of insulation were used. Moreover, for the transmission of alternating currents wires of smaller conductivity, according to the ordinary resistance measurements, may be used than is possible if they were constructed of copper, iron or other single metal.

The patentee states that he is aware of what is popularly termed the "Ferranti effect," and that it has long been known that in the mains of Ferranti's circuit potentials are higher at a distance than at the source of generation; but notwithstanding prior knowledge of this law or effect, he believes that he is the first to point out the fact that alternating transmissions are aided or made more perfect by the use of bimetallic conductors.

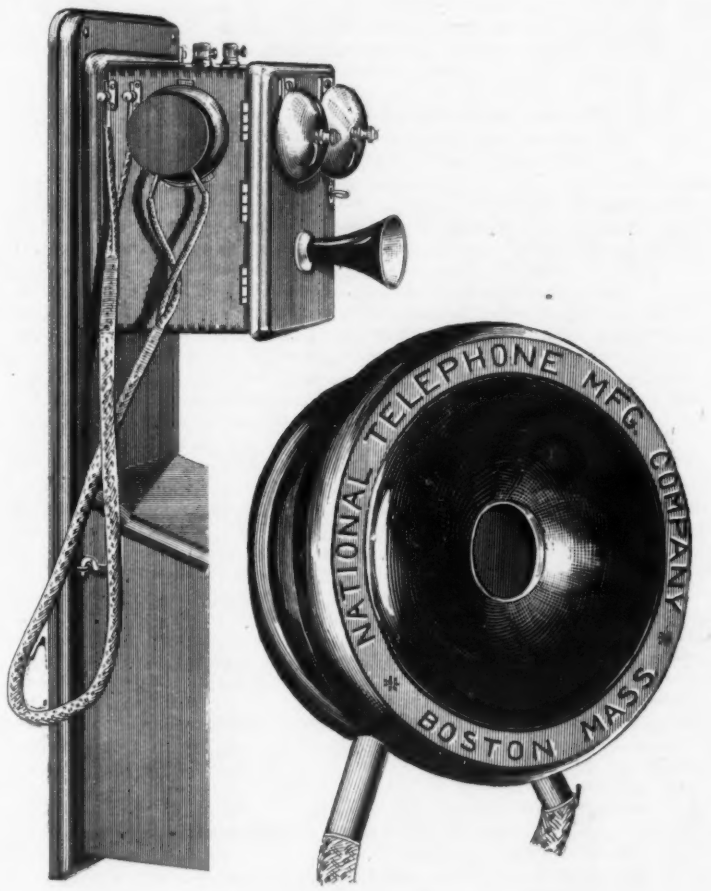
Either iron or steel may be used with copper, but steel is better adapted to the purposes of bimetallic wire and its use in transmitting alternating currents to great distances. Other dissimilar metals of essentially different specific resistances may be used to advantage in transmitting alternating currents, but to what extent their adoption would be beneficial the patentee is unable to state. The accompanying illustration shows a bimetallic wire with an iron or steel core with a copper coating.

Mr. Eckert has no theory to account for his claims, which he bases upon actual realizations. Among the experiments made was to lay a composite bare wire of No. 20 B. & S. gauge ten miles long on the ground, when it was found that telephonic articulation was not impaired. Mr. Eckert also recalls the telephonic experiment over the composite line of the Postal Telegraph Company between New York and Cleveland and New York and Chicago in 1883, when, with the circuit grounded at both ends, it was found that conversation could be carried on with ordinary Bell receivers. An account of these experiments will be found in The Electrical World of March 17 and 31, and April 14 and 21, 1883.

### Long-Distance Transmitter.

The accompanying illustrations represent a new long distance transmitter manufactured by the National Telephone Manufacturing Company, 620 Atlantic avenue, Boston, Mass. We are not at liberty at present to explain the construction of this new instrument, but it is claimed that it fully equals anything of its kind heretofore introduced to the public. The cut illustrates the little instrument full size, but it is nevertheless a compound receiver telephone and different, it is claimed, from anything of its kind ever produced in this country. The magnets are not horseshoe in shape, but full circles of the finest steel.

It has been the aim of this company to produce a telephone peculiarly is own in style and shape, and one that infringes




A NEW TELEPHONE.

no patents. It claims that in this it has succeeded, in which respect it is alone, and that it is now in correspondence with many street car, electric light and even Bell sub-companies for the purchase of its instrument, which are sold outright.

### The New-Comer in the Electrical Field.

The Walker Manufacturing Company, of Cleveland, Ohio, whose intention of entering the electrical manufacturing field we have before referred to, announces that it has made all preparations and is now about to commence manufacturing electrical manchinery and appliances. With the fine manufacturing equipment of this company, its eminent business qualifications and competent technical advisers, there can be no doubt as to the high standing it will take and the services it will render to the electrical industry.

### Injunction Dissolved.

On Tuesday, Jan. 23, Judge Ricks dissolved, without bonds, the injunction against the Buckeye Electric Company of Cleveland, Ohio.

# Financial Intelligence.

## The Electrical Stock Market.

New York, Jan. 22, 1894.

THE ELECTRICAL STOCK MARKET has strengthened considerably during the week, like the other industrials. This is due in a large measure to Secretary Carlisle's issue of bonds, which put a better tone on the whole market. From the ready demand for the bonds there seems to be plenty of purchasers for good securities, and when the electrical stocks are proven to be a thoroughly safe investment there will be no trouble in disposing of them to the public.

GENERAL ELECTRIC stock has been under fire during the week, but has lost but a fraction of a point thereby. There was a well-concerted bear attack on the stock at the announcement of a receiver for the local Thomson-Houston Company, but as the General Electric people had no connection with it, the bear raid failed and the stock has held its own. Transactions in it were heavy, 10,244 shares being sold on Thursday. The selling was largely on Boston orders. The stock showed greater strength during the week than it has for some time. It is now offered at 36⅛.

THE EDISON ELECTRIC ILLUMINATING COMPANY has issued its annual report and the directors are much encouraged over it, for, despite the prevailing hard times, the demand for light has exceeded the company's capacity to supply. The ratio of increased earnings, as might be expected, is not as great as in former years, though there was a gain of 22 per cent. in net earnings for 1893 over 1892. The report shows gross earnings for 1892 to be $1,193,338, an increase of $250,763 over the preceding year, and a surplus in the treasury of $42,794. Since 1890 the gross earnings have increased from $488,595 to $1,221,560, and the net from $33,222 in 1884 to $581,678. The company now has almost four times the number of customers that it had in 1890, and is running 192,691 incandescent lamps and 2,538 arc lights. During the year $1,000,000 of bonds were disposed of, and the company has now $750,000 under option. The bond sale was required for additional plant in order to meet the demand for more light, but it is thought that the bonds out will be sufficient to meet all needed additions for 1894. The authorized capital stock is $10,000,000, of which $2,062,000 is in the treasury. The first mortgage bonds authorized are $4,312,000, of which $750,000 are in the treasury, but on which an option has been given. The only change made in the management at the annual meeting was the election of W. E. Glyn as a director in the place of Director Henry, who has resigned. The stock of the company is still quoted a trifle below par owing to the depressed stock market and its now being an ex-dividend security. This is a low figure for a good 6 per cent. stock, and is considerably below the Edison Illuminating properties of Philadelphia and Chicago. A year ago the New York Edison stock was ranging around 120, rivalling the General Electric Company. From the present quotation, 99, it is seen that it has stood fire much better than the General Electric security, and the transactions in it on the Exchange show it to be looked upon as a sound investment. In view of the fact that the business of the company is said to have increased 33 per cent. the first fifteen days in January over that of last year, and with the indications of a stronger electrical stock market, the stock looks like a good purchase.

THE BROOKLYN EDISON ELECTRIC ILLUMINATING COMPANY stock is quoted one point lower than at the close of last week, as it is ex-dividend. The annual report of the company shows an increase of net earnings of $62,242, which indicates that the Brooklyn Edison, considering its capitalization, compares favorably with the Edison companies of other large cities. During the past week the bids for lighting the streets and public buildings of Brooklyn were opened, and it is thought the Edison people will secure a good share of the contract. The field has hitherto been entirely occupied by the Municipal and Citizens' electric light companies, but since the change in the municipal government the Edison people will probably be given their due rights. The Edison stock is a 5 per cent. security and is now held at 101.

ELECTRICAL STOCKS.

| | Par. | Bid. | Asked. |
|---|---|---|---|
| Brush Ill., New York | 50 | 20 | 40 |
| Detroit Electrical Works | 10 | 2 | 3 |
| Cleveland General Electric Co | — | 85 | 90 |
| East River Electric Light | 100 | — | 65 |
| Electric Con. & Supply Co., pref | 15 | 15 | 16 |
| " " " " com | 15 | 15 | 17½ |
| Edison Electric Ill., New York | 100 | 96 | 99 |
| " " " 1sts | — | 108 | — |
| Edison Electric Ill., Brooklyn | 100 | 99 | 101 |
| " " " Boston | 100 | 112 | 117 |
| " " " Chicago | 100 | 145 | 150 |
| " " " Philadelphia | 100 | 120 | 130 |
| Edison Electric Light of Europe | — | 2½ | 4 |
| " Bonds | — | 80 | 85 |
| " Ore Milling | — | 5 | 10 |
| Fort Wayne Electric | — | 4 | 8 |
| General Electric Company | 100 | 35¾ | 36⅜ |
| " " " deb. 5's | — | 72 | 74 |
| Interior Conduit and Ins. Co | 100 | 25 | 35 |
| Mount Morris Electric | — | — | 65 |
| Westinghouse Consolidated | 50 | 41 | 43 |
| " " " pref. | 50 | 23½ | 24½ |
| Western Union Telegraph | — | 85⅝ | 85¾ |

## New Incorporations.

THE BLACK AND BOYD MANUFACTURING COMPANY, capital stock $25,000, has been formed to manufacture electric light and gas fixtures. J. E. Black, 139 East 21st street; W. P. Boyd, 216 West 22d street, and H. Plant, 14 East 87th street, all of New York, are the organizers.

THE WALLACE ELECTRIC COMPANY, Chicago, Ill., capital stock $2,000, has been formed to manufacture, buy, sell, etc., electrical goods and supplies, etc., etc. The incorporators are W. J. Candlish, K. V. Lansing and F. Pebbles.

THE A. C. WOLFRAM ELECTRIC COMPANY, St. Louis, Mo., capital stock $20,000, has been formed to manufacture and sell electrical machinery, etc. The promoters are A. C. Wolfram, T. J. Wolfram and H. W. Buckner, all of St. Louis.

THE BIG HOLE IMPROVEMENT COMPANY, Butte, Mont., capital stock $100,000, has been formed to supply electric power, electric railways, and other improvements. W. A. Clark, A. H. Wethey and C. W. Clark are the interested parties.

THE MANCELONA ELECTRIC LIGHT AND POWER COMPANY, Mancelona, Mich., capital stock $10,000, has been formed to furnish electricity for light, heat and power. J. W. Morris, J. H. Andrews and J. R. Jenkins, of Mancelona, are the interested parties.

THE LAKE CHELAN AND COLUMBIA VALLEY RAILROAD COMPANY, Spokane, Wash., capital stock $500,000, has been formed to carry on a general steamship, railroad and electric motor business. F. H. Cook and L. C. Cook, of Spokane, are interested therein.

THE FISHER ELECTRICAL MANUFACTURING COMPANY, Detroit, Mich., capital stock $50,000, has been formed to manufacture and sell electric lighting plants, steam engines, dynamos, etc. C. H. Meday, W. E. Reilly and F. E. Fisher, Detroit, Mich., are interested.

THE LEFFLER ELECTROMAGNETIC RAILWAY COMPANY, Chicago, Ill., capital stock $1,000,000, has been formed to manufacture and construct electrical, magnetic and electromagnetic railways, cars, motors, conduits, systems, machines and appliances. P. W. Leffler, W. I. Platt and James Brady are the incorporators.

THE PRIESTLY ELECTRICAL SUPPLY COMPANY, San Francisco, Cal., capital stock $100,000, has been formed to manufacture and deal in electrical apparatus and machinery, patents and patent rights. L. G. Harvey, J. M. Beck, E. M. Bray, E. F. Murdock, all of Oakland, and H. E. Wright, San Francisco, Cal., are the promoters.

THE HOLT ELECTRIC STORAGE COMPANY, Camden, N. J., capital stock $10,000, has been formed to manufacture, buy and sell storage batteries, electrical supplies, etc. The organizers are N. H. Edgerton, Kirkland; A. B. Felt, 1,509 Columbia avenue; L. H. Clymer, 1,608 North Eighth street, and J. F. Holt, 1,935 Poplar avenue, Philadelphia, Pa.

THE GREAT BRITAIN AND CONTINENTAL PRINTING TELEGRAPH COMPANY, New York, maximum capital stock $1,000,000, has been formed to construct, equip and maintain lines of telegraph in Great Britain, Germany, Belgium, and all other countries of continental Europe. The organizers are C. F Meek, New York; Joseph Thorne, Port Richmond, N. Y., and Abner McKinley, Canton, Ohio.

THE HARBOR LIGHT AND POWER COMPANY, San Francisco, Cal., capital stock $100,000, has been formed for manufacturing machinery, etc., for generating light, heat and power, and to deal in and operate telephone and other lines, etc., etc. The promoters are A. Devoto, W. B. Breadwell, H. J. Kuhlmeyer, W. W. Brown and G. B. Fraley, all of San Francisco, Cal.

# Special Correspondence.

## New York Notes.

Office of The Electrical World,
167-176 Times Building, New York, Jan. 22, 1894.

MAYOR GILROY has approved the resolutions authorizing the extension of the Lexington Avenue Street Railroad to the Astoria Ferry, and the building of a connecting line by the Ninth Avenue road from 125th street to the Fort Lee Ferry.

HON. C. P. VEDDER has been elected by a unanimous vote general manager of the Cataract Electric Company, which company owns the rights for the distribution of electricity from Niagara for all of New York State outside of Erie and Niagara counties.

THE THOMSON-HOUSTON ELECTRIC COMPANY, of New York, has gone into the hands of a receiver, at the instance of Henry R. Worthington, a judgment creditor of the company for $1,576.53. As the company is only a local one and has no connection with the General Electric Company, it had no bearing upon the electric stock market.

THE LONG ISLAND TRACTION COMPANY has secured con-

trol of the Broadway and associate lines of Brooklyn, and, according to President Daniel F. Lewis, of the Brooklyn City Railroad Company, the consolidation forms the most extensive system of street surface railroads in the world. The capital of the company is $10,000,000, and the system will cover 106 miles of track when the lines are extended as intended. As the trolley system is the motive power, it means big contracts for the electric companies.

ELECTRICITY ON THE BROOKLYN BRIDGE.—A correspondent writes to the "Morning Advertiser" as follows: "I see that the project to put the trolley on the Bridge is beginning to take shape in a proposition from the Brooklyn and Kings County Elevated railroads to the trustees. There is a big steal in this and I advise the 'Morning Advertiser' to look out for it. It is an attempt to still further aid the Brooklyn elevated roads at the expense of the people."

MR. J. KYTE COLLETT, in a recent isue of the New York "Herald," describes a plan for rapid transit which was submitted by him to the Rapid Transit Commissioners when they first took up the consideration of the problem of rapid transit in New York. It consists, briefly, of a car or carriage suspended from an aerial cable and provided with one or more aeroplanes. The motive power would be electricity. High rates of speed would be possible, he claims, because the weight of the cars at such speeds would be sustained by the aeroplanes.

R. T. WILSON & CO. has proposed to the Rapid Transit Commission to construct underground railways in New York, using electricity as the motive power, and also for light and heat, as follows: From the Battery, underneath Broadway and the Boulevard to Fort George on the West Side; another projected line would start from 14th street and Broadway and run up Fourth avenue to 42d street, and thence to Harlem, possibly through Madison avenue or Lexington avenue. The proposition is coupled with the condition that the city shall loan the enterprise $30,000,000 of the $45,000,000 required.

THE JAMAICA AND BROOKLYN RAILROAD COMPANY stockholders on Jan. 15 met at the office of the Broadway Railway Company, No. 29 Broadway, and ratified a lease by which the companies are practically consolidated. The Broadway Company controls the East New York line, Reid avenue line, and Sumner avenue line. Hereafter the companies will be known as the Brooklyn, Queens County and Suburban Railroad Company. Rumors have been in circulation for some time that the Brooklyn City Railroad Company was negotiating for the purchase of the Broadway Company. Last evening at the office of the latter company no information on this subject would be given. That a lease between the Broadway Company and the Jamaica and Brooklyn Company had been signed was the only information obtainable.

## New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Jan. 20, 1894.

MR. J. N. EMMONS is now in charge of the General Electric factories at Lynn. Some of the departments are being consolidated and will remain at Lynn, it is said.

HON. MOODY BOYNTON has asked for the grant of charters for elevated bicycle railways connecting all the depots of Boston, with branches radiating to Cambridge, Somerville, Lowell, Lynn, Salem, Beverly, Quincy, Brockton, Dedham, Attleboro and Providence.

THE COMMITTEE ON MERCANTILE AFFAIRS of the Massachusetts House of Representatives gave a hearing Jan. 18 on Representative Hoar's bill to place the wires of Boston underground. Among those in attendance were Vice President Cummings and Counsel Hyde, of the West End Street Railroad Company; Fire Commissioners John R. Murphy and George H. Innes, and Osborne Howes, Jr., secretary of the fire underwriters. Mr. Murphy stated for the fire department that he was not particular that all wires should be placed underground now, but that a beginning should be made in that direction in the congested part of Boston, where, he said, 20 per cent. of the wires were high tension. He stated that his department could do better work with no overhead wires, and that also by the removal of them from overhead to underground the insurance companies would lower rates. The hearing was adjourned one week, when further information will be received.

## Canadian Notes.

OTTAWA, Jan. 20, 1894.

LETHBRIDGE, N. W. T.—The Cardston Telephone Company is seeking incorporation.

OTTAWA, ONT.—The loss by fire at the Electrical Railway Company's sheds was $2,500. The company had $1,000 insurance in the Atlas Insurance Company, which it received on the preceding Thursday.

HAMILTON, ONT.—The Hamilton, Grimsby and Brantford Electric Railway Company has let the contract for building eleven trolley cars to Ahearn & Soper, of Ottawa. Three of these will be cars for fruit and milk. The others will be fitted with plate-glass vestibules in front for the protection of the motormen, will have Maguire trucks and all the latest improvements. Several of the cars will be short four-wheeled coaches, such as are used on the James street south line in the city, and the remainder will be long eight-wheel cars, especially adapted for long-distance running.

## English Notes.

(From Our Own English Correspondent.)

LONDON, Jan. 10, 1894.

THE ELECTRIC ACCUMULATOR INDUSTRY.—The London "Gazette," of Friday last contained an announcement of the Home Secretary, placing electric accumulator works within the category of factories in which dangerous occupations injurious to health are carried on. This classification enables the aforesaid official to interfere more or less in the management of such works.

ELECTRIC MOTORS IN THE ROYAL NAVY.—Last week H. M. S. "Centurion," one of our new battleships, was put through her gunnery trials. The "Centurion" is interesting as being the first battleship of the Royal Navy in which use is made of electric motors for heavy gun working. So far their application will be very tentative, and restricted to elevating the big guns and to shot-hoisting, hand gear being available in each case, in the event of breakdown.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.—The founders of this society, which has been formed by electrical engineers resident in the North of England, have lost no time in getting to work. The first meeting was held at Manchester a week or ten days ago. Dr. John Hopkinson was unanimously elected first president of the society, and a council was formed, amongst whom are Dr. Edward Hopkinson, of Messrs. Mather & Platt; Mr. A. R. Bennett, of the New Telephone Company; Mr. Henry Edmunds, of Messrs. Walter Glover & Co., and three or four municipal electric lighting engineers.

ELECTRIC LIGHT MAIN ACCIDENTS.—On Monday last no less than three distinct accidents were caused by electric light mains. In London the lids of two street boxes were blown off, one being smashed to pieces and severely injuring a passer by. In Newcastle an employe in the service of the National Telephone Company was engaged in melting the ice off the lid of a telephone duct-box when an explosion occurred which resulted in severe injury to the man. At Bournemouth, as a two-horse omnibus was proceeding along the streets, one of the horses suddenly fell down dead. Investigation revealed that the ground for some distance around was electrically charged, presumably by a leak to earth from the high pressure electric light main running under the roadway.

# News of the Week.

## Electric Light and Power.

TOLEDO, OHIO.—It is proposed to use electricity on the swing bridges.

DENISON, IOWA.—Residents are again agitating the matter of electric lights.

OPELIKA, ALA.—The Opelika electric plant will be enlarged and improved.

SIGOURNEY, IOWA.—William Fuller is organizing an $8,000 electric company.

MILAN, TENN.—Residents are working for electric lights and waterworks system.

CHATHAM, N. Y.—Thomas E. Sterne is thinking of establishing a power and light plant at his mill.

NORWOOD STATION, DELAWARE COUNTY, PA.—Residents of Norwood have voted for electric lights.

IPAVA, ILL.—Residents of Ipava, in Fulton county, are discussing the matter of an electric lighting plant.

ATLANTIC CITY, N. J.—Proprietor White, of the Luray, proposes to purchase an electric plant for his hotel.

EASTON, PA.—Bonds are to be issued to the amount of $2,000 for the purchase of an extra dynamo and belting.

QUITMAN, GA.—Residents of Quitman have voted to issue $20,000 in bonds for waterworks and electric lighting plant.

PITTSBURG, PA.—A project for generating electricity at the Kanawha Falls to supply light, heat and power has been revived.

EGG HARBOR CITY, N. J.—The Council of Egg Harbor City has awarded the contract for electric street lighting to A. Bolker.

CLAY CENTRE, KAN.—P. W. Wickstrum is interested in the scheme to put in an electric lighting plant in connection with the flouring mill.

FITCHBURG, MASS.—A bill to enable cities and towns to manu-

facture their own electricity and gas is before the House of Representatives.

TOLEDO, OHIO.—Harbor Master Sheldon is moving in the matter of changing the motive power to operate swing bridges from steam to electricity.

NEWTON, N. J.—There is much talk of the poor quality of the light furnished by the gas company here, and a proposal for electric lights is being discussed.

ATTLEBORO, MASS.—Owing to complications of the street railway company here, the town is in darkness. There are poles and connections but no power.

POWELTON, PA.—The Powelton Electric Light Company, of which W. J. Latta is president, will extend its plant to the city limits. They will issue $150,000 of new stock.

THE STATE ELECTRIC LIGHT AND POWER COMPANY, of Brooklyn, has renewed its application for an electric lighting franchise and the matter has been referred to the proper committee.

NEWTON, KAN.—The Newton city electric light plant has been leased by James D. Nicholson from the Newton Real Estate and Investment Company. Mr. Nicholson will manage the business hereafter.

PARSONS, PA.—The Anthracite Light, Heat and Power Company has been formed to supply Parsons, Miner's Mills and Plains. Some of the incorporators are W. S. Mears, Alexander Simpson, F. W. Bleckley and A. B. Turner.

MONROE, LA.—The Monroe Electric Light and Water Company, which has one of the most complete plants in this section, is now running almost full capacity. The company has found it necessary to open an uptown office.

MONTREAL, CAN.—The Royal Electric Company proposes to locate a plant in Carleton Place, near Ottawa, and the residents there are urging Parliament to allow them to grant an exemption from taxation and a $20,000 bonus.

PALMER, MASS.—The Palmer and Monson Electric Company has formed the Central Massachusetts Electric Company to give service to Warren, West Warren and West Brinfield. The capital stock will be increased from $75,000 to $150,000.

YORK, PA.—Residents are discussing the report of the special committee appointed in the matter of electric street lighting, which was that a plant would cost $35,000 and that it could be run at a cost of $10,000 per annum. No definite action has yet been taken.

KEARNY, N. J.—Councilman Kenny, of the Kearny Township Committee, has been instructed to request Assemblyman Kerr to support and work for the passage of an act to permit incorporated townships to maintain and use electric lighting plants and issue bonds therefor.

JAMESTOWN, N. Y.—The Jamestown "Journal" is very bitterly opposed to the proposed expenditure of $30,000 for enlarging the present electric light plant. It quotes figures to prove that Jamestown is paying a high price for inefficient light and asks that the matter be reconsidered.

RUMFORD FALLS, ME.—The Rumford Falls Light and Power Company has applied for right to extend its electric light and power system along the highways and public roads of Rumford. The matter will be given a public hearing at the office of the Rumford Falls Power Company on Jan. 29 at 2 p. m.

JERSEY CITY, N. J.—Sealed proposals will be received to 4 p. m. Feb. 1 for furnishing an electric lighting plant (steam) for the purpose of lighting the new public road, as per detail to be had of the Clerk of the Board of Freeholders, or at the office of the engineer of the new public road, in the Fuller Building, Jersey City, N. J. John Boyd is clerk of the board.

GRIFFIN, GA.—Mayor Boyd states that a contract has been entered into between the city and the Southern Engineering and Construction Company, of Atlanta, Ga., to put in a complete new electric lighting plant before the 15th of March. There will be two dynamos run by a 125-h. p. engine. E. W. Dutton is the manager of the Southern Engineering and Construction Company.

LANCASTER, PA.—Sealed proposals will be received until 7 p. m. Jan. 26 by H. F. Metzger, chairman of the Lamp Committee, at the Mayor's office, Lancaster, Pa., for lighting the city, 2 miles square, with 205 or more electric arc lights; also for lighting the Central Market house with eight or more electric arc lights; also for furnishing gas per 1,000 cubic feet; all as per details to be had of said Metzger. David L. Deen, clerk of the committee, will also give details.

READING, PA.—A new company will be organized in Reading to be known as the Metropolitan Electric Company, and it will apply for a charter on Feb. 8 through Solicitor Richmond L. Jones. It proposes to furnish light and power and has selected a site for its plant at the foot of Chestnut street. John A. Rigg, Richmond L. Jones, Robert N. Carson, R. Nelson Buckley and David C. Golden are interested.

CLEVELAND, OHIO.—Sealed proposals will be received at the office of the Board of Control, 105 City Hall, to Jan. 26, for furnishing and delivering at the foundations of the Division street pumping station one 115-volt compound wound dynamo, with a capacity of 300 16-c. p. 60-watt 110-volt incandescent lamps; also, one single cylinder non-condensing horizontal cut-off engine which shall develop 50-brake horse power. Each bidder on dynamo and engine is required to state in his bid the amount he will deduct from the same for the dynamo, engine and ampere meter now in use at the waterworks. J. H. Farley is Director of Public Works.

## The Electric Railway.

WILLIMANSETT, MASS., is considering the building of a street railway to Holyoke.

MARLBORO, MASS.—The State Central Railway has received a franchise from the authorities of Marlboro.

BEREA, OHIO.—The Cleveland and Berea Street Railway Company will at once change to the trolley system and purchase rolling stock.

ST. LOUIS, MO.—The St. Louis and Baden Railway Company has issued $250,000 twenty-year bonds to pay for the cost of changing the motive power to electricity.

WAVERLY, N. Y.—A. N. Brodhead and H. D. Wade, of Jamestown, are in town looking up a site for the power house of the electric road. Three carloads of poles have arrived.

KINGSTON, PA.—The Dallas and Harvey's Lake Electric Railway Company has been granted permission to build an electric line on Hoyt, Chestnut and Pringle streets.

SHREVEPORT, LA.—The electric road, gas and light companies have consolidated. This takes in two electric street roads, and the light and gas plants, which will be operated under one management.

NORTHAMPTON, MASS.—The Northampton Street Railway Company has asked for leave to make certain extensions, and a public hearing will be given at 4 p. m. Jan. 26 in the Aldermen's rooms in the City Hall.

NORWICH, CONN.—The Norwich "Record" is authority for the statement that General Manager Shaw, of the Norwich and New London Street Railway, contemplates extensive improvements in the New London service.

FRANKLIN FALLS, N. H.—The Franklin Falls "Journal" is authority for the statement that a party of capitalists have offered to build, equip and operate an electric railroad between Exeter and Hampton Beach.

OAKLAND, CAL.—The Oakland Railway Company has reincorporated for $2,500,000. Chas. F. Crocker, H. F. Huntington, S. T. Gage, and F. S. Douty are interested. They will build about five miles of extensions.

NORWALK, CONN.—The Norwalk and South Norwalk Horse Railroad Company will double track West avenue and prepare their entire road for the trolley system. Work will be begun as soon as the weather permits.

THE PORTLAND (ME.) STREET RAILWAY COMPANY has re-elected the old board of directors. The directors' report shows the past year's gross earnings to have been $200,779; operating expenses, $174,130; net earnings, $26,647.

WOODBURY, N. J.—A special meeting of the Council of Woodbury will be held Feb. 2 in the matter of granting a franchise to the Camden, Gloucester and Woodbury Electric Railway. J. Willard Morgan is president of the company.

ALBION, ORLEANS COUNTY, N. Y.—A committee is to be appointed to look into the matter of the proposed electric elevated railway to Batavia. Judge Q. S. Signor and D. W. Beckwith are interested and will represent the interests of the citizens of Albion.

PLAINFIELD, N. J.—Messrs. Thomas, Nevins, Riker and Serrell have offered to build an electric road in New Brunswick, N. J., but the Aldermen and the capitalists cannot come to terms as to the time to be given for building the road, and the project hangs fire.

TAMAQUA, PA.—At a meeting of the stockholders of the Tamaqua and Lansford Street Railway Company F. P. Spiese was elected president, P. J. Ferguson treasurer, and A. P. Blakeslee secretary. They will build the road as soon as right of way can be secured.

NEWCASTLE, DEL.—The Newcastle and Wilmington Electric Railway, it is stated on good authority, will soon be built, and it is expected that it will be finished in May. Preston Lea and Willard Salisbury, of the Wilmington City Railway Company, are interested in the enterprise.

NEW BRUNSWICK, N. J.—The Common Council of New Brunswick and the City Railway Company have locked horns in the matter of permitting the company to change its motive power to electricity, it now being horses. The principal ground of difference is the time to be allowed for completing such proposed change.

HOMESTEAD, PA.—An ordinance has been submitted to the Council granting right of way to the Homestead and Highland Railway Company, in combination with the Pittsburg and Homestead Railway Company. This would shut out the Second Avenue Traction Company and the Pittsburg and Birmingham

Traction Company, and was vigorously opposed, and the matter deferred to Jan. 20 for action.

NIAGARA FALLS, N. Y.—The Niagara Falls "Journal" states that the parties engaged in the enterprise of building a street railway from the city of Niagara Falls to the Devil's Hole say that they have money enough subscribed to build the road, and that work will be commenced in the early spring and it will be in running order by June next.

PITTSBURG, PA.—A meeting of railway men interested in the proposed new line from West Bellevue to the Perryville road has been held and the report of the preliminary survey showed that the line could be built for $25,000. Secretary W. D. Henry, of the Pleasant Valley Railway, states that the road will be built if the money can be raised. Part of this sum has been subscribed.

PASSAIC, N. J.—The Passaic Common Council has granted a franchise to the Paterson, Passaic, Rutherford and Carlstadt Electric Railway Company to build its line through the city. It will run from Paterson to Jersey City. Councilman Huber, who headed the opposition, has asked for an ordinance granting franchise to the Passaic and Newark Electric Company, which will be granted at the next meeting.

WORCESTER, MASS.—The Worcester and Millbury Street Railway Company proposes soon to take definite steps in the matter of extending its lines from the present terminus at Bramnaville through Sutton and Grafton to Northbridge, and it is now before the Legislature with a bill applying for such right and also for right to issue bonds at the rate of $15,000 per mile, to run twenty years. It proposes thus to cover the intended route of the projected Blackstone Valley Railway, which company failed to float its stock.

NANTASKET, MASS.—The scheme for leasing the Old Colony track along the beach at Nantasket to a corporation that desires to operate it by electricity has not developed beyond the stage of inquiry between the parties. An electric company desires to have the entire operation of the road northerly of the Nantasket steamboat pier and the remainder of the road during the months in which the Old Colony people do not desire to operate it. The outcome of the project is yet quite uncertain.

AUGUSTA, ME.—Augusta is having a street railway war, which will be of doubtful termination. The Mayor declared the principal street of the city unsafe and ordered the street commission to fill in the track, which was done, but the street railway company reopened it. The Board of Aldermen has passed an order and served notice to compel the company to keep the streets safe for travel for their entire width. The company declares the city must pay for damage caused by filling its tracks.

NORWALK, OHIO.—Mr. J. H. Stewart, of Sandusky, who had charge of the building of the Short Line Railroad, was in the city recently in consultation with several business men who are interested in the building of an electric road from Norwalk to Fairfield and the south part of the county. Upon looking over the map of the county, Mr. Stewart was much impressed with the idea of building this road. He estimates the cost of the road from here to Fairfield and Greenwich, 17 miles, at about $200,000.

ALLEGHENY CITY, PA.—An ordinance has been presented and referred to Corporations Committee, granting the Pittsburg, Allegheny and Manchester Traction Company the right to use electricity or cables as motive power on railways owned or operated by the Pittsburg, Allegheny and Manchester Company, or the Pittsburg Union Passenger Railway Company. Another ordinance was similarly referred granting to the Pittsburg Union Passenger Railway Company right of way on certain streets.

GARDNER, ME.—The incorporators of the Gardner Electric Street Railway Company are duly organized for business, having chosen L. A. Greenwood, James A. Styles, Charles Heywood, George R. Godfrey, of this town; M. A. Coolidge, F. S. Coolidge, of Fitchburg, and E. F. Blodgett, of Leominster, as temporary directors. They ask the Selectmen for a franchise, and propose a route about three and one-half miles long, connecting the three villages with each other and with the stations of both railroads. Work will begin as soon as practicable, and supplies will be promptly on hand.

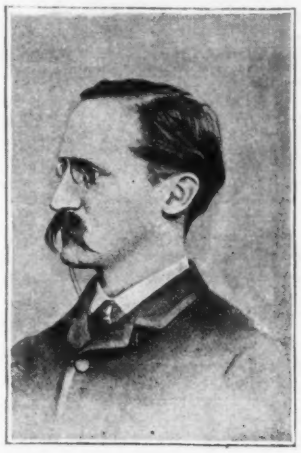
ANDOVER, MASS.—A majority of the directors of the association for the formation of the South Side Street Railway Company, Messrs. Larkin T. Trull, J. L. Chalifoux, W. S. Knox, C. T. Guild, Winslow Goodwin and M. E. Clemons, have petitioned the Board of Selectmen for a location for their proposed electric road in the streets of Andover, Mass., and the said Selectmen, Messrs. Arthur Bliss, Samuel H. Boutwell and John S. Stark, have called a public meeting, to hear such petition in the Town Hall of Andover, at 2 p. m., Jan. 31.

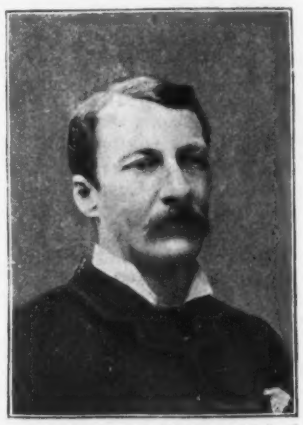
NORTHAMPTON, MASS.—The directors of the Northampton Street Railway Company have voted to build the proposed extensions from this city next spring to Williamsburg and to Easthampton. The surveys have been made to Williamsburg for some time, and that was looked upon as a sure thing, but the Easthampton route has burst upon the public with greater suddenness. A few days ago Engineer Strong began the survey which he has just completed. The directors also voted to pay a quarterly dividend of $2 per share. If the roads go through in the spring it will be necessary to increase the stock of the company.

## Personal.

MR. ROBERT B. CARTER, the father of Mr. Franklin C. Carter, of the Partrick & Carter Company, Philadelphia, Pa., died at Riverton, N. J., Jan. 14, aged 72 years. Mr. Carter was well-known in New York and Long Island (his former home). For many years he had been retired from active business and had devoted his time and talents to literary work and benevolent enterprises, and was among the earlier and active promoters of the Society for the Prevention of Cruelty to Animals. Mr. Carter possessed a genial nature which endeared him to a large circle of friends.

PROFESSORS ROWLAND AND FORBES, whose names are now so prominently before the public in connection with the Niagara plant, both began their careers as teachers at about the same age and in the same year, 1872, Prof. Henry A. Rowland as instructor in physics at the Rensselaer Polytechnic Institute, Troy, N. Y., and Prof. George Forbes as professor of natural philosophy at Anderson College, Glasgow, Scotland. From Rensselaer Polytechnic Prof. Rowland was called to Johns Hopkins University, where he has since remained and continued the scientific work which has placed him among the great physicists of the world. The career of Prof. Forbes has been more varied, but yet eminently successful, though in more practical and active lines. While attached to Anderson College he was sent, in 1874, in command of a British expedition to the Sandwich Islands to observe the transit of Venus, and in 1877 acted as special correspondent of the London "Times" during the Russo-Turkish war, and was the only Englishman who gained access to the Russian camps in Asia. In 1881 Prof. Forbes became manager of the British Electric Light Company, and the next year began to practice as a consulting engineer, which he has since continued Prof. Forbes is of distinguished ancestry and the son of the famous Prof. Forbes, of Edinburgh University, and a member of many learned societies of Europe. The writings of Prof. Rowland have been confined to papers and articles published in various scientific collections and periodicals, including The Electrical World, giving the result of original researches and of his remarkable experimental investigations. Prof. Forbes is the author of a book on the "Transit of Venus of 1874," of one on "Glaciers," and of the well-known "Lectures on Electricity," and of numerous papers read before learned bodies on various subjects, mostly electrical, many of which are notable for their deduction of practical applications from theoretical principles.





GEORGE BARTLETT PRESCOTT, one of the pioneers in the electrical field, died of heart failure at the Buckingham Hotel on Thursday afternoon, after an illness of two weeks. Mr. Prescott was born in Kingston, N. H., on Sept. 16, 1830, and was a descendant of James Prescott, an incorporator of the town in 1694. He received his education principally at private schools in Portland, Me., and began in 1846 the study of electricity. He learned the art of telegraphy soon after its invention by S. F. B. Morse, and from 1847 to 1858 was manager at New Haven, Boston, Springfield and other telegraph offices, after which he was superintendent of the American Telegraph Company, and later on superintendent of the Western Union Telegraph Company. He was electrician of the International Ocean Telegraph Company from 1873 to 1883, and for several years he was one of the vice presidents of the Gold and Stock Company, and also one of the incorporators of the Metropolitan Telegraph and Telephone Company. He was president of the Manhattan Telegraph Company and the American Speaking Telephone Company. While manager of the Boston office, in 1852, he made the discovery that the aurora borealis is of electrical origin and published an account of the discovery. On various occasions he removed the batteries from the telegraph wires and operated the latter by means of the current induced by the aurora. Mr. Prescott's name is connected with several important inventions relating to telegraphy, including the quadruplex and duplex telegraph systems, the use of pneumatic tubes for the transmission of messages, etc. At the request of Postmaster General Dennison, he wrote a paper on the proposed acquisition of the telegraph by the Government, which was incorporated in the Postmaster General's report. He ap-

peared frequently before various committees of Congress, and wrote many pamphlets in opposition to the Government's control of the telegraph. Mr. Prescott was the author of the following works on electrical subjects: "History, Theory and Practice of the Electrical Telegraph," "Electricity and the Electric Telegraph," "The Speaking Telephone," "Dynamo Electricity," "Bell's Electric Speaking Telephone, Its Invention, Construction, Application, Modification and History" and "The Electric Telephone." Mr. Prescott married Miss Eliza Curtis Parsons, a granddaughter of General Israel Parsons, of Revolutionary fame. He retired from active participation in business in 1882, and after that devoted himself exclusively to literary pursuits. He leaves mourning him his widow and only child, Mrs. Philip V. R. Van Wyck, Jr.

## Miscellaneous Notes.

THE WORLD'S FAIR authorities will have sufficient money left over to pay its stockholders a dividend of 10 per cent. at least.

AN INTELLIGENT LEGISLATOR.—A bill has been introduced in the New York Legislature by a member requiring all wires used by trolley roads to be insulated.

PRESIDENT MATTINGLY, of Vicksburg, Miss., says that since the announcement of Mr. Walter Mattingly's resignation in The Electrical World, he has had worlds of applications from all sections of the country.

A NEW ELECTRIC FURNACE.—Henry S. O'Neill, of Boston, claims to have succeeded, by the use of the electric current, in obtaining a temperature above that hitherto attained, and, moreover, in regulating the temperature to any degree required.

COPPER AND THE TARIFF.—The New Bedford Copper Company says it expects its business will be greatly promoted if the Wilson tariff bill passes in its present form. It has prospered under the McKinley bill, which reduced the duty on copper ore. The present bill removes it altogether, and once it goes into effect the market will be considerably enlarged.

THE HON. LEVI P. MORTON, whose stock barn at Rhinecliff, N. Y., was destroyed by fire some months ago, is rebuilding another, in which he is evidently determined to prevent a like occurrence. The barn will cost about $75,000, and is to have a very complete electrical equipment. Among other devices will be an electric clock system of four stations, and the Electric Heat Alarm Company, of Boston, will have 300 thermostats in the building.

ECONOMIC USE OF TRANSFORMERS.—Mr. W. Forman Collins read a paper before the recent meeting of the Northwestern Electrical Association at Milwaukee on the "Economic Use of Transformers," which is in many respects a model of what such a paper, intended for a non-technical audience, should be. The theory of the transformer is simply explained, its construction described and the main points bearing on its use in distribution described.

THE DRAWBAUGH TELEPHONE COMPANY, of Philadelphia, has been organized with a capital stock of $2,000,000, and in a proposition for a city ordinance fixes a maximum charge of $78 a year for business houses and $50 to private families within the city limits, the Bell rates ruling now from $120 to $420 a year; gives the city free ducts in the conduits for telephone and telegraph purposes, and 2 per cent. of the gross receipts for the privilege of using the streets, and also provides free 'phones to all the city departments.

## Trade and Industrial Notes

MR. A. B. LAWRENCE, 225 Pearl street, New York, is sending to his friends and patrons a handsome roll calendar, which he will also mail to engineers and superintendents should they send a two-cent stamp with their name.

WILLIAM S. HINE has recently severed his connection with the Case Engine Company, and will take charge of the electrical supply warehouse at Chicago of the Stanley Electrical and Manufacturing Company, of Pittsfield, Mass.

THE RAILWAY EQUIPMENT COMPANY, of Chicago, of which Mr. W. R. Mason was the manager, has transferred to Mr. George O. Fairbanks, as assignee, all its property for the benefit of its creditors. Claims against the Railway Equipment Company are to be sent to the assignee at 305 Ashland Block, Chicago.

HINE & ROBERTSON believe in the old adage that "in union there is strength." They appreciate the superior merits combined in the Robertson-Thompson indicator, as owned by the New York Indicator and Specialty Company, of 106 Liberty street, and have brought about a consolidation, so that the new firm of Hine & Robertson Co., 57 Cortlandt street, New York, now controls both the Improved Straight Line and the Robertson-Thompson indicators.

MR. WM. H. McKINLOCK, president of the Metropolitan Electric Company, has been called to New York to close a contract for a full line of specialties, which that company is now in a position to handle advantageously in its commodious store and warerooms, 186 and 188 Fifth avenue. Here they have ample room for the display of specialties and are in a position to take care of their rapidly increasing business.

MESSRS. CARLISLE & FINCH have bought the repair shop and business of the General Electric Company, of Cincinnati, Ohio, and will continue the business and do all kinds of electrical repairing and manufacturing. Mr. Morton Carlisle and R. S. Finch, who form the firm, have been for a long time connected with the General Electric and Thomson-Houston interests, and the repair works were formerly conducted by Mr. Finch.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 36 Cortlandt street, New York, in a circular, states that after Feb. 15 they will announce telephonic devices to replace those covered by the Bell Company's patent on magneto bells with automatic switches changed by the weight of a telephone receiver, and on the shunt of the generator armature being automatically cut out by turning the crank that revolves the generator.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., has recently added several improvements to its Washington alternating arc lamp which make the lamp even more desirable than it was as originally placed on the market. A highly polished metal reflector has been placed over the outside of the globe which can be used or not as desired. The metal base of the lamp has been done away with entirely, leaving nothing whatever on the lower part of the globe to obstruct the light, and also shortening the lamp several inches, so that a 15-hour lamp is now only a trifle over 20 inches long over all.

THE JENNEY ELECTRIC MOTOR COMPANY, of Indianapolis, Ind., reports the following sales: One thousand light plant for the Park Gate Hotel, Chicago; 1,500-light central station plant for Washington, D. C.; central station lighting plant for Marceline, Mo.; 500-light isolated plant at Louisville, Ky.; a 500-light plant at Poughkeepsie, N. Y.; 120-light plant, Piggott, Ark.; 120-light dynamo, Hartford, Conn.; 80-light dynamo, city; 50-light plant for a dredge at Chicago. This company has just received an order for a complete lighting plant for the large mill of the Leonard Paper Box Board Company at Carthage, Ind. In addition to the above the company reports the sale of quite a number of motors and smaller lighting plants.

THE WESTON ELECTRICAL INSTRUMENT COMPANY was made to claim, in a recent advertisement in The Electrical World, that it had received the only award for testing instruments at the World's Fair. It is only fair to the company to say that it has not made any such claim, and that it was an employee of The Electrical World who, with well-meant zeal, added the line to the advertisement on the subject of awards. The Weston measuring instruments are so well known and bear such a deservedly high reputation in America that it is flattering to our national pride to know that even the foreign visitors at the World's Fair expressed the warmest admiration of their handsome design and workmanship, as well as of their accuracy and reliability.

THE DAY-MOBERG ELECTRIC COMPANY, 54 Pearl street, Boston, has recently placed upon the market a storage battery which, it is claimed, is giving most excellent results. The battery is known as the "Jupiter," and it is claimed is so constructed as to render short-circuiting absolutely impossible, possessing also other valuable advantages and differing materially from other storage batteries. Mr. Henry H. Day, manager of the company, states that business is very gratifying and is confident over the hold the battery will eventually obtain in the market. The Day-Moberg Company also makes a specialty of repairing dynamos, motors and storage batteries, and thoroughly charges storage batteries for 50 per cent of the usual rates.

THE SWAN LAMP MANUFACTURING COMPANY, of Cleveland, Ohio, held its annual meeting on Jan. 16. Myron T. Herrick, who has been president and director of the company since its organization, owing to pressure of other duties, declined a renomination. The following officers were elected: S. M. Hamill, president and general manager; B. F. Miles, vice-president and treasurer; S. E. Cox, secretary and superintendent; E. P. Roberts, electrician. The secretary, Mr. Cox, made an annual report in which he stated that the business of the company was unusually large for the past year, and that they were at present from 25,000 to 30,000 lamps behind their orders. The Swan Lamp Company has been one of the most successfully managed of all companies manufacturing electrical apparatus during the past ten years.

THE ROYAL ARC ELECTRIC COMPANY, 143 Liberty street, New York, and 13 Haynes street, Hartford, Conn., is meeting with a flattering success with its new incandescent arc lamp. The Underwriters' International Electric Association, after carefully investigating the lamp, reports its unqualified approval of it as a spark arrester, which action will guide that of other underwriters' bodies throughout the country. Among many testimonials is the following from Hartford, Conn., where the lamp is also used for street lighting: "We have had on the arc light in our store one of the Howard cylinders since the 15th of last October. The cylinder has never been changed, but is the identical one that was originally put on and has been in constant use without any signs of breakage. We have never had so good a light before, and have greatly enjoyed the freedom from noise

and dirt, and especially the relief from our former anxiety as to damage from fire."

MR. R. D'UNGER, Chicago, Ill., in a recent communication, claims that his patent, issued Oct. 2, 1888, "is the only valid all-carbon microphone and transmitter patent in existence in this country." This telephone is now the property of the D'Unger Long Distance Telephone Company, of Chicago. The Chicago Twin Wire Long Distance Telephone Company owns the rights for Chicago and Cook county, Ill. They have a 25 years' franchise, he states, from the city of Chicago, and will put in 5,000 public and 15,000 subscribers' instruments within two years from the date of the passage of the franchise. The system used will be the Mann, which it is claimed does away with the expensive and intricate switchboard now used. It is also claimed that the telephone speaks clearly and distinctly through a resistance of 70,000 ohms, and out-of-door tests of 500 miles have been made with a resistance of 30,000 in circuit with excellent success. The instrument requires little or no care.

MR. WILLIAM HAZELTON, 3d, has been appointed the exclusive agent for the United States of the Societe Anonyme Industrielle des Etablissements Arbel, Rive-de Gier (Loire), France. This company is probably the best known manufacturer in Europe of wrought iron forged centres for all kinds of wheels, making a specialty of this business. Mr. Hazelton has opened offices in the Havemeyer Building, New York City. The wrought iron forged centres of the Arbel manufacture are especially adapted to cable and electric service, and are sold with a five years' guarantee. These centres are used almost exclusively in France and many other European countries. Since Mr. Hazelton resigned from the Short Electric Railway Company, last summer, he has, in addition to devoting much time to several railway projects in which he is interested, been negotiating with several large manufacturers to represent them in the East. He will continue in the contracting for and building of street railways complete, in which line he is well known, and has had a long long practical experience.

## Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

# Illustrated Record of Electrical Patents.

### U. S. PATENTS ISSUED JAN. 9, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

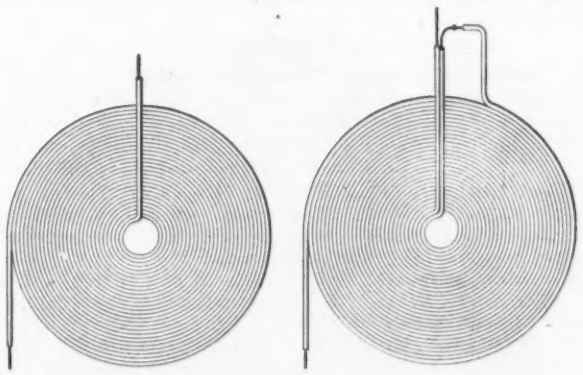
512,316. ELECTRIC VALVE CONTROLLER; C. E. Ongley, New York. Application filed Dec. 18, 1890. The combination, with a cylinder and piston, or a similar motor, and pipes leading to opposite sides of the piston, of an apparatus for controlling the pipes, consisting of a cylinder having a single valve seat, a valve therefor, an armature connected to the valve, a magnet in operative relation to the armature, a waste pipe and a slide valve in the waste pipe common to both valve mechanisms and moved by water pressure.

512,320. ELECTRIC INCANDESCENT LAMP; John Peil and Carl K. MacFadden, Chicago, Ill. Application filed April 18, 1893. In electric incandescent lamps the combination with a glass bulb of a metallic cap, a fusible metallic seal, and inleading metallic wires provided with a vitreous coating inserted through the seal.

512,327. ELECTRICALLY PROPELLED VEHICLE; James Harris Rogers and Willard Fracker, Washington, D. C. Application filed Jan. 31, 1893. In combination with a frame provided with a hook by which it is adapted to be detachably connected at its front end to the front wheels of a vehicle, the battery carried thereby, the wheels at the rear end of the frame, and the motor geared to the wheels.

512,331. ELECTRIC CUT-OUT; Albert P. Seymour, Syracuse, N. Y. Application filed Nov. 18, 1892. In an electric cut-out, the combination of flat line and fuse clamp plates projecting beyond supporting shoulders or offsets on the base and cover respectively, whereby they may be hooked together, and screws tapped into the clamps on the cover from the exterior thereof.

512,340. COIL FOR ELECTROMAGNETS; Nikola Tesla, New York, N. Y. Application filed July 7, 1893. A coil composed of contiguous or adjacent insulated conductors electrically connected in series and having a potential difference of such value as to give to the coil as a whole a capacity sufficient to neutralize its self-induction. See illustration.



NO. 512,340.—COIL FOR ELECTROMAGNETS.

512,373. TROLLEY CUT-OUT; Melanchton Hanford, Malden, Mass. Application filed Sept. 22, 1893. In combination with a suitable hanger, and two bolts segmental in cross-section, two oppositely disposed rocker-plates formed with hooks at one end and tubular arms at the opposite ends, said hooks to engage said bolts, and two independent lengths of trolley wire electrically united and affixed at their extremities to the plates.

512,378. TIME AND DATING STAMP; W. C. Jewell, Indianapolis, Ind. Application filed July 11, 1891. This consists of a device for conjunctively operating the hour, meridian and minute wheels, comprising a bent lever fulcrumed within the minute wheel, lever mechanism acting on the bent lever, whereby the latter is caused to periodically engage the adjacent wheel, and rigid connections between the hour and meridian wheels.

512,386. ELECTROMAGNET; Frank R. McBerty, Downer's Grove. Application filed May 16, 1893. The combination with a tubular magnet of radical arms of magnetic material connecting the core with the shell of the magnet, and a mass of conducting metal surrounding the arm.

512,395. PRODUCING ILLUMINATING LETTERS; James Harris Rogers, Washington, D. C. Application filed Feb. 28, 1893. As a means for producing a predetermined illuminated design, the combination with a group or bank of electric lamps, composed of a number of independent sections, arranged in separated and independent lines, each section with an independent wire, to which each light in the section is connected by a short wire, a source of electric energy having one of its poles connected electrically with all of said lamps, a pivoted circuit making and breaking device provided with contact points and electrically connected with each section, and electrical connections between all of such devices and the other pole of the source of energy.

512,397. SPARK REGULATOR FOR DYNAMO-ELECTRIC MACHINES; Charles E. Scribner, Chicago, Ill. Application filed June 1, 1889. The method of preventing sparking, which consists in maintaining, under given conditions, a practically constant field for the short circuited coil, the strength of said field being adjusted to build up a current in the short circuit coils which shall be practically equal to the current in the current producing coils, into the circuit of which said short circuited coils are introduced in the rotation of the armature.

512,398. APPARATUS FOR TELEPHONE SWITCHBOARDS; Charles E. Scribner, Chicago, Ill. Application filed April 26, 1893. This consists of a switch lever, actuated by the pressure of a connecting plug in its socket, a catch engaging the switch lever to retain it in one of its positions, and means for actuating the catch to release the switch lever.

512,399. APPARATUS FOR TELEPHONE SWITCHBOARDS; Charles E. Scribner, Chicago, Ill. Application filed April 26, 1893. The combination with two connecting plugs of continuous conductors connecting the like parts of the two plugs together, a self-restoring annunciator having its operating coil connected with the plug circuit, a generator of signaling current, a key for connecting the same with the plug circuit, the restoring or retaining coil of the self-restoring annunciator being included in the normally open circuit of the generator.

512,400. AMERICAN DISTRICT ELECTRIC SIGNAL APPARATUS; Charles E. Scribner, Chicago, Ill. Application filed Dec. 27, 1886. The combination with the carrying shaft of the spring rigidly connected therewith and provided with a roller at its free end, and an engagement wheel mounted loosely upon said shaft; whereby, while the shaft is turning, the engagement wheel is carried by the roller.

512,401. DUPLEX ARC LAMP; Charles E. Scribner, Chicago, Ill. Application filed May 1, 1891. In a duplex arc lamp, the combination of a single carbon arc lamp whose carbons rest in contact when the lamp is idle, connected to supply mains, of a second arc lamp provided with mechanism adapted to maintain the carbons separated when the lamp is idle, and with an electromagnet in shunt of the carbons of both lamps, which acts upon the said mechanism to cause the approach of the carbons toward each other when sufficient current passes through the electromagnet.

512,413. TELEPHONE CALL RECORDER; William B. Thomson, Chicago, Ill. Application filed June 28, 1893. A telephone wire,

two transmitting mechanisms connected with its opposite ends and two recording mechanisms also connected with the opposite ends of the recording devices, a galvanometer needle adapted to be oscillated in either direction by the passage of a current about it, two electric circuits, including the electromagnets, respectively, and each adapted to be closed by the oscillation of the needle in the proper direction and two galvanometer coils encircling the needles, respectively, and each formed with a break adapted to remain closed as long as the corresponding transmitter is not in operation, but to be opened when the transmitter begins to operate.

512,422. PRINTING TELEGRAPH; Emil A. Wirsching, New York, N. Y. Application filed May 12, 1893. The combination with a driving gear of an electric motor having a rotating armature connected with and adapted to operate the gear in a direction reverse to the normal.

512,424. ALTERNATING CURRENT DYNAMO; James J. Wood, Fort Wayne, Ind. Application filed June 23, 1893. In a dynamo a brush holder adapted for holding two brushes tandem, consisting of a double socket piece formed at its middle with a boss for receiving the supporting stud, and two sockets for the respective brushes on opposite sides of said boss extended at such an angle converging toward the tips of the brushes as to bring the latter closely adjacent to each other.

512,425. CONNECTION BETWEEN SEPARATELY EXCITED DYNAMOS AND THEIR EXCITERS; James J. Wood, Fort Wayne, Ind. Application filed Oct. 17, 1893. The combination with a separately excited dynamo having an adjustably mounted surbase, of an exciter for said dynamo adjustably mounted on a movable base, and a rigid connection between the surface of said separately excited dynamo and the movable base of said exciter, whereby the latter follows the movements of the former and the tension of the driving belt between the two is preserved.

512,444. CLOSED CONDUIT RAILWAY; Charles J. Kintner, New York, N. Y. Application filed June 22, 1893. In an electric railway system a series of removable pivoted switching boxes carried each by a shaft journaled in the sides of the conduit, and mechanically actuated switching devices inclosed wholly in said boxes.

512,448. SOCKET FOR INCANDESCENT LAMPS; Thomas L. Pfarr, Jr., Pittsburg, Pa. Application filed Feb. 13, 1893. In combination with a bulb holder for an incandescent lamp having one or more openings in the side of the case thereof, binding screws with which the charged wires engage, and spring contact pieces connected to the respective binding screws, and a branch fitting or plug having one or more projecting pieces containing spring contact points adapted to engage with the spring contact pieces of the bulb holder.

512,454. TIME INDICATOR ATTACHMENT FOR TELEPHONES; Charles Stever, San Jose, Cal. Application filed March 24, 1893. In a time indicator the combination of a movement having an arbor, a wheel thereon having notches in its periphery, an independently turnable segment plate in connection with said wheel and adapted to cover or to expose one or more of the notches thereof, and a sounding hammer having a stem or shank resting upon and actuated by said notched wheel, to deliver successive strokes.

512,464. INCANDESCENT LAMP; Augustus C. Carey. Lake Pleasant, Mass. Application filed March 29, 1893. In an incandescent lamp, a globe, or bulb, having a tubular butt provided with a tapering bore, combined with an illuminating tube having a stopper adapted to be fitted to such bore.

512,473. SECONDARY BATTERY; F. K. Irving, New York, N. Y. Application filed Sept. 13, 1892. This comprises a gauze plate folded to form pockets, the porous cups within the pockets and binding rods surrounding the gauze elements in a group.

512,481. ELECTRIC ARC LAMP; R. Niewerth, Berlin, Germany. Application filed March 22, 1893. This comprises a series of electrodes arranged around a common centre and adapted to be rotated on their axis, a commutator and brushes for supplying the electric current and imparting alternate polarities to the electrodes.

512,482. ELECTRIC ARC LAMP; R. Niewerth, Berlin, Germany. Application filed Oct. 24, 1893. This comprises a series of electrodes arranged around a common axis and means for supplying the electrodes in pairs successively with electric currents in opposite direction, so as to impart alternately positive and negative polarities to the electrodes and form a continuous arc of uniform size.

512,510. DEPOLARIZER FOR VOLTAIC CELLS; G. Hewett, New York, N. Y. Application filed April 3, 1893. An article of manufacture composed of a depolarizer for voltaic cells consisting of nitric acid, sulphuric acid and bichromate of sodium in the form of a dry powder.

512,514. ELECTRODE FOR SECONDARY BATTERIES; W. Morrison, Des Moines, Ia. Application filed April 25, 1892. An article of manufacture consisting of a plurality of bundles built up to form a continuous ribbon, to become active, and conducting rods connecting the bundles together.

512,535. ELECTRIC RAILWAY CURRENT COLLECTOR; E. M. Boynton, West Newbury, Mass. Application filed Oct. 12, 1893. In an electrically propelled bicycle car, the combination with the guide wheels of current collectors guided and carried by the frame work of the wheels.

512,567. BATTERY; W. M. Stine, Athens, O. Application filed July 21, 1891. In a storage battery, an alkaline electrolyte formed of a mixture of sodium hydrate, sodium zincate, sodium chloride and sodium chlorate, the whole in aqueous solution.

512,603. ELECTRICAL TRANSFORMER OR CONVERTER; C. L. Coffin, Detroit, Mich. Application filed Dec. 11, 1891. In a transformer or converter a secondary formed of perforated metal.

512,604. APPARATUS FOR ELECTRICALLY WELDING METAL; C. L. Coffin, Detroit, Mich. Application filed March 9, 1893. The combination of means for connecting the metal to a source of electricity, an extraneous conductor connected to the other terminal of the source of electricity, two extraneous conductors and means for maintaining an electric arc between the electrodes within the field of force of a magnet.

512,612. DEVICE FOR BLOWING OUT SPARKS ON COMMUTATORS OF DYNAMOS; H. W. Hanahan, Winnsborough, S. C. Application filed March 28, 1893. This comprises a commutator having radial slots and longitudinal passages extended nearly through the commutator at the bottom of the slots and communicating therewith, and a stationary air chamber surrounding the armature shaft, of an adjustable non-rotary disc located in the air chamber at one end of the commutator and provided with apertures that are adapted to register at intervals with the longitudinal passages of the commutator and through which air will pass from the air chamber to the slots of the commutator to prevent sparking.

512,614. ELECTRIC SWITCH; J. L. Hinds, Syracuse, N. Y. Application filed May 16, 1892. This comprises a base plate provided with a pair of terminals, a lever having contact faces adapted to engage the terminals, supports hinged to the lever and push buttons removably mounted on the supports.

512,637. INCANDESCENT ELECTRIC LAMP; J. W. Turnbull, Pascagoula, Miss. Application filed May 2, 1893. The combination with a bulb of a separable tube, open at both ends, inserted therein and forming therewith a vacuum chamber.

512,656. RELAY; F. M. Locke, Victor, N. Y. Application filed June 19, 1891. The method of overcoming the effect of residual magnetism upon the armature of electromagnets, consisting in maintaining from one magnet pole through the receding armature to the other magnet pole a magnetic circuit.

512,667. DOUBLE CARBON ARC LAMP; C. E. Scribner, Chicago, Ill. Application filed April 16, 1892. The combination of a yoke and two symmetrical clutch mechanisms for the different rods, a retaining magnet and its pivoted armature lever adapted to support one or the other of the mechanisms to relieve the yoke of the weight thereof, and a cut-out, one of the contacts thereof being carried on the same lever with the yoke.

512,672. FIRE ALARM ATTACHMENT; C. E. Egan, Chicago, Ill. Application filed May 27, 1893. The combination of a chambered block, a disc in the chamber, a cross-bar with an adjustable screw in position to bear against the disc when heated, and a push button and housing for the same removably secured to the block.

---

U. S. PATENTS EXPIRED JAN. 2, 1894.

185,841. MULTIPLE CIRCUIT CLOSERS FOR ELECTRIC CIRCUITS; J. H. Striedinger, New York, and A. Doerflinger, Brooklyn, N. Y. This comprises an independent actuating circuit having a suspending device and a circuit closing plate, all arranged so that by closing the actuating circuit the main circuit will also be closed.

U. S. PATENTS EXPIRED JAN. 9, 1894.

186,104. AUTOMATIC ELECTRIC TELEGRAPHS; R. K. Boyle, New York, N. Y. This comprises a local battery, two alternately charged induction coils, whereby a series of waves of electricity of the same kind are sent over the wire.

U. S. PATENTS EXPIRED JAN. 16, 1894.

186,215. PRINTING TELEGRAPH TRANSMITTERS; G. M. Phelps, Brooklyn, N. Y. This comprises rollers, a lever, hook, revolving finger, crank, circuit rocker, and connections to the distant printing telegraph instrument.

186,234. ELECTROMAGNETIC DENTAL PLUGGERS; J. E. Dexter, New York, N. Y. The combination of a spring yoke, vibrator and spring contact piece.

186,330. ACOUSTIC ELECTRIC TELEGRAPHS; T. A. Edison, Menlo Park, N. J. The combination with a receiving magnet of a condenser in a shunt around such magnet.

186,340. ELECTRO-HARMONIC TELEGRAPHS; E. Gray, Chicago, Ill. This consists in working a closed circuit with a continuous current from a main battery, portion of the whole of which currents are thrown into vibration at will by the transmitters.

186,355. UNDERGROUND TELEGRAPH LINES; W. Mackintosh, New York, N. Y. The combination with blocks of incased conduits, of split and lapped cement tubes, also made solid in a cement block, to take the place of a removed conduit block.

186,356. UNDERGROUND TELEGRAPH LINES; W. Mackintosh, New York, N. Y. For the purpose of looping cable in branch offices, an embedded conduit, severed at two points, and looping pipes, combined with the disjointed ends thereof.